Propaq® CS
Vital Signs Monitor

Service Manual

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Advancing Frontline Care™

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This device complies with Part 15 of the FCC rules and with the rules of the Canadian ICES-003. Operation is subject to the following two conditions: (1) This device may not cause harmful interference and (2) this device must accept any interference received, including interference that may cause undesired operation.

Caution! Changes or modifications not expressly approved by Welch Allyn could void the purchaser's authority to operate the equipment.

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1 Safety summary

Warnings

This Safety Summary should be read by all Propaq CS monitor users. Specific warnings and cautions are placed throughout the documentation where they apply.

Caution: Federal (U.S.A.) law restricts this device to sale, distribution, or use by or on the order of a licensed medical practitioner.

WARNING Place the Propaq monitor and accessories in locations where they cannot harm the patient if they fall from their shelf or mount. Lift the monitor only by its handle; do not lift it by any attached cables.

WARNING Do not connect more than one patient to a monitor. Do not connect more than one monitor to a patient.

WARNING Do not use the monitor in an MRI suite or a hyperbaric chamber.

WARNING Do not autoclave the monitor. Autoclave accessories only if the manufacturer's instructions clearly approve it. Many accessories can be severely damaged by autoclaving.

WARNING Inspect the power adapter cord periodically for fraying or other damage, and replace the adapter as needed. Do not operate the apparatus from mains power with a damaged power adapter cord or plug.

WARNING Make frequent electrical and visual checks on cables and electrode wires.

WARNING When connecting the Acuity hardwire connection, connect the Propaq CS monitor to an Acuity system only. Connecting to other networks could damage the monitor or injure a patient.

WARNING Safe interconnection between the Propaq monitor and other devices must comply with applicable medical systems safety standards such as IEC 60601-1-1. Within certain governmental jurisdictions, all interconnected accessory equipment must be labeled by an approved testing laboratory. After interconnection with accessory equipment, risk (leakage) current and grounding requirements must be maintained.

WARNING As with all medical equipment, carefully route the patient cabling to reduce the possibility of patient entanglement or strangulation.

WARNING Avoid electrosurgery burns at monitoring sites by ensuring proper connection of the electrosurgery return circuit so that the return paths cannot be made through monitoring electrodes and probes.

WARNING During defibrillation, keep the discharge paddles away from ECG and other electrodes, as well as other conductive parts in contact with the patient. Avoid contact with any accessories connected to the monitor's left side panel.

WARNING To ensure patient safety, the conductive parts of the ECG electrodes (including associated connectors) and other patient-applied parts should not contact other conductive parts, including earth ground, at any time.

WARNING Do not operate this product in the presence of flammable anesthetics or other flammable substance in combination with air, oxygen-enriched environments, or nitrous oxide; explosion can result.

WARNING The pulse oximetry channel should NOT be used as an apnea monitor.

WARNING This monitor is to be operated by qualified personnel only. The operator of this monitor should read this entire manual, the monitor *Reference Guide* or *Directions For Use*, and all accessory *Directions For Use* before operating the monitor.

WARNING This monitor should only be repaired by qualified service personnel. The operator should not attempt to open the monitor case or perform any maintenance on the monitor except for procedures explicitly described in this manual that can be performed by operators such as inspection and cleaning.

WARNING When using a power adapter with this monitor, be sure to connect the power adapter to a three-wire, grounded, hospital-grade receptacle. Do not under any circumstances attempt to remove the grounding conductor from the power plug of the power adapter. Do not plug the power adapter into an extension cord. If there is any doubt about the integrity of the protective earth ground of the receptacle for the power adapter, do not plug in the power adapter; operate the monitor only on battery power. Contact your biomedical engineering department for assistance in identifying the proper power receptacle and making appropriate power connections.

Note Within certain governmental jurisdictions, all interconnected accessory equipment must be labeled by an approved testing laboratory. After interconnection with accessory equipment, risk (leakage) current and grounding requirements must be maintained.

- To ensure conformance to risk (leakage) current requirements when operating from an ac mains power source, use only a Welch Allyn's 503-0054 series power adapter.
- To ensure patient safety, use only accessories recommended or supplied by Welch Allyn. For a list of those accessories, see the Welch Allyn *Products and Accessories* book that accompanied this manual (PN 810-0409-XX). Accessories must be used according to your hospital's standards and the manufacturer's recommendations. Always refer to the manufacturer's directions for use.
- A product that has been dropped or severely abused should be checked by qualified service personnel to verify proper operation and acceptable risk (leakage) current values.
- If the monitor detects an unrecoverable problem, an error message window appears containing an error number and a short message. Report such errors to Welch Allyn.

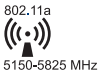
- While under warranty, the monitor should be serviced only by a Welch Allyn service technician.

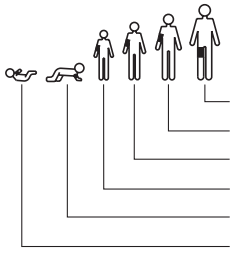
Definitions

Note	Identifies information that may be important to the reader.
Caution	Identifies conditions or practices that could result in damage to equipment or other property.
WARNING	Identifies conditions or practices that could result in personal injury.

Symbols

The following symbols may appear on the Propaq CS monitor or accessories. They are defined by the International Electrotechnical Commission, IEC 878 and IEC 417A.

	Off (Standby)		Two-way communication port
	On		Input port
	For continued fire protection, use only the specified fuse		Output port
	Direct current		Alternating current
	Non-ionizing electromagnetic radiation. This device contains an approved RLAN module frequency 2402 to 2480 MHz		Non-ionizing electromagnetic radiation. This device contains an approved RLAN module frequency 5150 to 5825 MHz
	Fuse		Recycle the monitor and battery separately from other waste. Refer to www.welchallyn.com/weee for collection point and additional information.
	Direct current or alternating current		Separate batteries from other disposables for recycling.
	Caution: Refer to Directions For Use and accompanying documentation	IPX1	Enclosure Protection Drip proof: Classification IPX1 per IEC Publication 529
	See the accompanying manual		Urgent alarm notification (output to Nurse Call system)
	Battery charging when green indicator illuminated		Temperature sensor input
	Patient connections are Type CF, isolated for direct cardiac application, and protected against defibrillation		Transformer meets requirements of a short-circuit-proof safety-isolating power transformer
	Patient connections are Type BF, and protected against defibrillation		For indoor use only (on power adapter only)
	Protected during defibrillation		Stacking limit by number
	This way up		Temperature limits
	Fragile	n%	Humidity limit

Keep away from rain	Altitude limit
Patient connections are Type B	The device has met all essential requirements of European Medical Device Directive 93/42/EEC for a Class 1 product
The CE Mark and Notified Body Registration Number signify the device has met all essential requirements of European Medical Device Directive 93/42/EEC	The Canadian Standards Association has evaluated this device according to CSA 601-1 and Underwriters Laboratory Standard UL 2601-1.
Restrictions for use of wireless device in Europe. European Communities Class 2 radio equipment	This device has been tested and certified by the Canadian Standards Association International to comply with applicable U.S. and Canadian medical safety standards.
 NIBP cuff sizes: Thigh, Large adult, Adult, Small adult, Child, Infant	Apply the NIBP cuff as shown.
	Apply the NIBP cuff as shown.
	Single-use only (not reusable).
FCC ID: PGUWA11A07 IC: 4168a-WA11A07	This device complies with FCC and Industry Canada requirements for international radiators (802.11 wireless)

2 Overview

Purpose and scope

The Propaq CS Service Manual is intended as a reference for monitor maintenance and repair to the field-replaceable unit (FRU) level ("Field Replaceable Units (FRUs)" on page 129). This manual provides the technically qualified service person with troubleshooting information, repair procedures, and calibration and performance verification instructions. A technical overview of the monitor subsystems is provided as an introduction to the device's circuitry and pneumatics.

This manual is intended for the technically qualified service person. Service training classes on Welch Allyn' products are available. Contact Welch Allyn Technical Service (page ii) for information.

Other applicable documents

Several other documents are available for the Propaq CS monitor. Refer to those documents for other than maintenance and repair information. Check the *Propaq CS Directions For Use* for information on other user's documentation.

Title	Part Number
Propaq CS Directions For Use, English	810-2689-XX
Products & Accessories Booklet	810-0409-XX

Unpacking procedure

Use the following guidelines when unpacking the monitor from its shipping carton.

1. Before opening the monitor shipping carton, check it for damage.
2. If damage is apparent, stop unpacking the carton and contact the shipping company for further instructions. If the carton is intact, unpack the monitor.
3. With the monitor out of its carton, check to see that all the items listed on the packing slip (provided with shipment) are in the shipping carton.
4. If an item is missing, first recheck the carton, then check with your receiving department. If necessary, contact Welch Allyn at the address and phone number shown in page ii.

Save the shipping carton and packing material for repacking the monitor in case it needs to be sent to a repair center or back to Welch Allyn for service.

Warranty service

DO NOT ATTEMPT TO REPAIR the monitor yourself during the warranty period. For service and repair, contact Welch Allyn. See below.

Technical support services

Welch Allyn offers a wide range of technical support services including:

- 24-hour telephone support
- loaner equipment
- service contracts
- field replaceable units (FRUs)
- factory repair

For any of these services, contact Welch Allyn Technical Support:

USA	1-800-535-6663	France	(+33) 1-60-09-33-66	Australia	(+61) 2-9638-3000
Latin America	(+1) 305-669-9591	Germany	(+49) 7477-927-173	Singapore	(+65) 6291-0882
European Call Center	(+353) 469-067-790	Canada	1-800-561-8797	Japan	(+81) 3-5212-7391
United Kingdom	0-207-365-6780	South Africa	(+27) 11-777-7509	China	(+86) 21-6327-9631

Worldwide Internet Access

World Wide Web (WWW) URL: http://www.monitoring.welchallyn.com/service
World Wide E-mail: solutions@monitoring.welchallyn.com

Recommended service intervals

At the intervals listed below, check the Propaq CS monitor for normal operation.

Interval/Condition	Perform	Located in this manual
Every 6 months to 2 years (according to hospital protocols).	Complete risk (leakage) current Safety Check followed by a Functional Verification.	"Functional verification"
If battery does not retain a charge.	Check battery pack capacity.	"Troubleshooting"
Monitor is dropped or suspected of damage or rough handling.	Complete Safety Check followed by Functional Verification.	"Functional verification"
Suspected malfunction with all or part of monitoring parameters.	Functional Verification of suspected parameter(s).	"Functional verification"
Monitor does not pass Functional Verification.	Calibration of monitoring parameter circuits, or repair, followed by Safety Check and Functional Verification.	"Functional verification" and "Calibration"

WARNING If the monitor is opened for repair or calibration, a dielectric strength test must be completed to ensure the integrity of the patient isolation barrier. The dielectric strength test procedure is provided in "Functional verification".

Identifying Propaq CS Monitor configurations

The following tables identify Propaq CS monitor configurations and how they are indicated. The model-option number and serial number are located on the back of the housing. The monitor indicators are located under the handle on the back.

Table 1. Propaq Monitor configurations

Product (housing)	Model number	Option Number	Parameters included (Acuity option is also available with every model)
Propaq CS Monitor	242		ECG, NIBP, 2 Temp, Resp Option, Nurse Call Option, Color Display
	244		ECG, NIBP, 2 Temp, 1 IBP, Resp Option, Nurse Call Option, Color Display
	246		ECG, NIBP, 2 Temp, 2 IBP, Resp Option, Nurse Call Option, Color Display
SpO_2-Only Module		210	SPO_2 Four Options Available: Nellcor MP-405 (Top level assembly 007-0059-XX) Nellcor MP-203 (Top level assembly 007-0020-XX) Nellcor MP-507, Nell-2[a] (Top level assembly 007-0109-XX) Masimo MS3 (Top level assembly 007-0060-XX)
Expansion Module	See next table		

a. Nellcor Nell-2 has superceeded MP-507.

There are two Acuity Wireless options available:

1. 2.4 GHz radio card (002-0150-00)
2. 5 GHz radio card (002-0160-00)

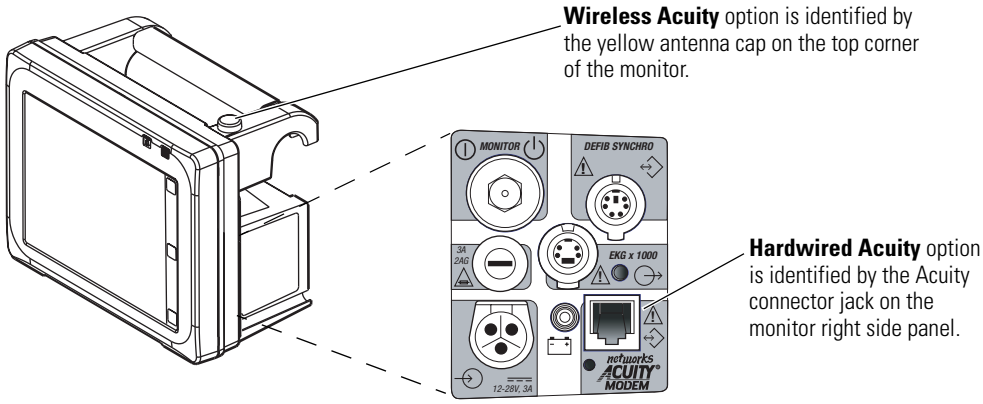
Caution The 2.4 GHz and 5 GHz radio cards are not interchangeable. Replacement of the radio card in the wrong configuration will cause permanent damage to the radio card and/or monitor hardware.

Table 2. Expansion module option configurations

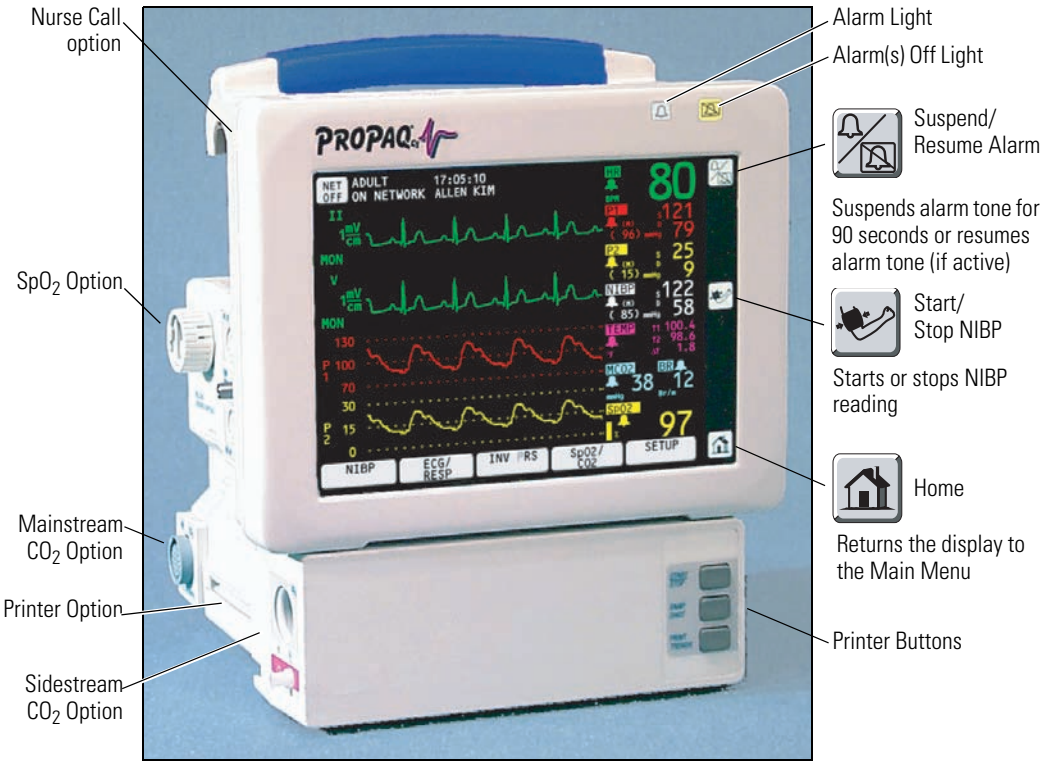
Option number	Printer	Mainstream CO_2	Sidestream CO_2	SpO_2	Top level assembly number
221	Yes	No	No	N/A	007-0046-XX
222	No	No	No	Nellcor MP-203	007-0050-XX
223	Yes	No	No	Nellcor MP-203	007-0047-XX
223	Yes	No	No	Nellcor MP-203	007-0051-XX
223	Yes	No	No	Masimo MS3	007-0069-XX
223	Yes	No	No	Nellcor MP-405	007-0086-XX
223	Yes	No	No	Nellcor Nell-2, MP-507[a]	007-0116-XX
224	No	Yes	No	Nellcor MP-203	007-0049-XX
224	No	Yes	No	Masimo MS3	007-0070-XX
224	No	Yes	No	Nellcor MP-405	007-0085-XX
224	No	Yes	No	Nellcor Nell-2, MP-507[a]	007-0115-XX
225	Yes	Yes	No	Nellcor MP-203	007-0048-XX
225	Yes	Yes	No	Masimo MS3	007-0071-XX
225	Yes	Yes	No	Nellcor MP-405	007-0084-XX
225	Yes	Yes	No	Nellcor Nell-2, MP-507[a]	007-0114-XX
226	No	No	Yes	Nellcor MP-203	007-0045-XX
226	No	No	Yes	Masimo MS3	007-0072-XX
226	No	No	Yes	Nellcor MP-405	007-0083-XX
226	No	No	Yes	Nellcor Nell-2, MP-507[a]	007-0113-XX
227	Yes	No	Yes	Nellcor MP-203	007-0043-XX
227	Yes	No	Yes	Masimo MS3	007-0073-XX
227	Yes	No	Yes	Nellcor MP-405	007-0082-XX
227	Yes	No	Yes	Nellcor Nell-2, MP-507[a]	007-0112-XX
228	No	Yes	Yes	Nellcor MP-203	007-0052-XX
228	No	Yes	Yes	Masimo MS3	007-0074-XX
228	No	Yes	Yes	Nellcor MP-405	007-0081-XX
228	No	Yes	Yes	Nellcor Nell-2, MP-507[a]	007-0111-XX
229	Yes	Yes	Yes	Nellcor MP-203	007-0044-XX
229	Yes	Yes	Yes	Masimo MS3	007-0075-XX
229	Yes	Yes	Yes	Nellcor MP-405	007-0080-XX
229	Yes	Yes	Yes	Nellcor Nell-2, MP-507[a]	007-0110-XX

a. Nellcor Nell-2 has superceeded MP-507.

Identifying the Acuity Communication options


Wireless Acuity option is identified by the yellow antenna cap on the top corner of the monitor.
MONITOR
DEFIB SYNCHRO
EKG x 1000
12-28V, 3A
networks ACUITY MODEM
Hardwired Acuity option is identified by the Acuity connector jack on the monitor right side panel.

Monitor controls



Self test and service menus

The Propaq CS monitor includes built-in self-tests that verify the integrity of its hardware and software each time you turn it on. If the monitor turns on and displays the Main Menu, all self-tests were passed. If a self-test results in a failure, a message and error code are displayed indicating the failure mode. Refer to "Troubleshooting" on page 55 and contact Welch Allyn Technical Support for help.

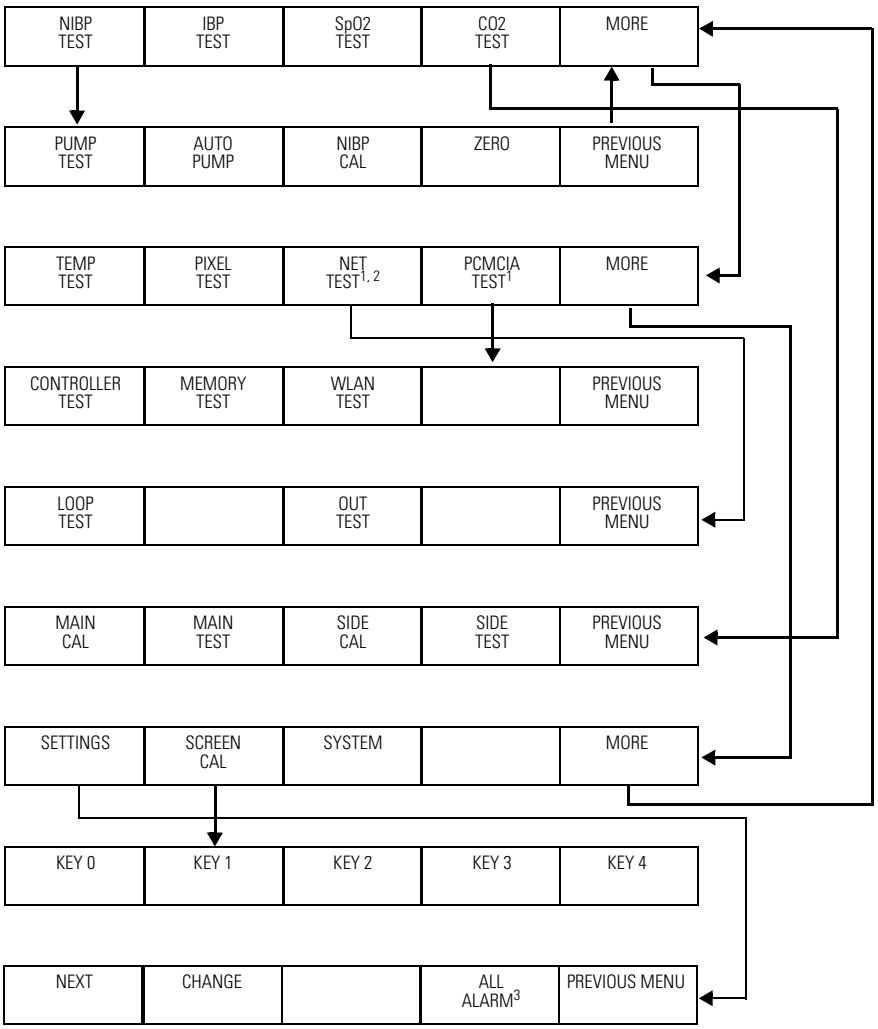
The Propaq CS monitor contains software routines that make the Functional Verification and Calibration procedures quicker and easier. You access these routines through the Service Menus as indicated in each of the procedures.

The figure below shows the hierarchy of the Service Menus once you enter the top level Service Menu.

The procedures in this manual indicate which buttons to push by separating each button menu name with the (>) character. For example, to access the Service Menu, the procedures would indicate for you to press **SETUP > MORE > MORE > SERVICE > YES**, which means you press the **SETUP** button, then the **MORE** button, then the **MORE** button, then the **SERVICE** button, and finally the **YES** button.

Note The figure illustrates the Service Menu functions. Some of these functions are not available if you do not have the appropriate option.

To access the Service Menu, from the Main Menu press: **SETUP > MORE > MORE > SERVICE > YES**.



[1]2.4 GHz radio card only.
[2]No function on 5 GHz radio card

[3]Software version 3.6x only.

Service test screens

There are two Acuity Wireless options available:

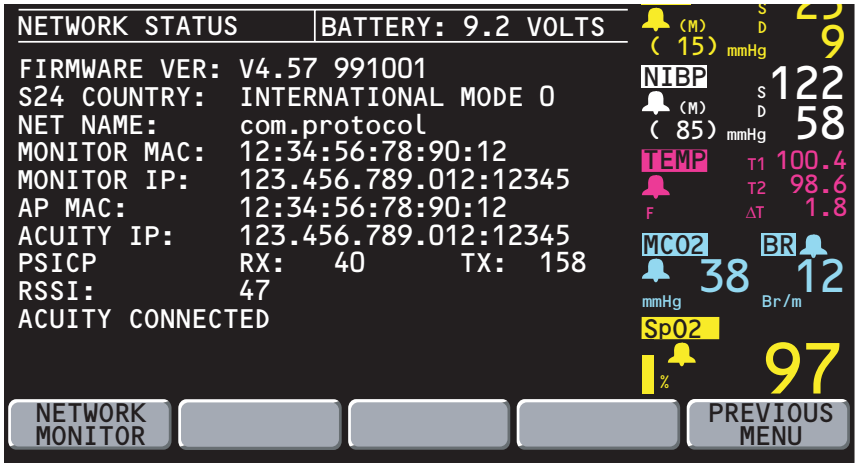
1. 2.4 GHz radio card (002-0150-00)
2. 5 GHz radio card (002-0160-00)

Caution The 2.4 GHz and 5 GHz radio cards are not interchangeable. Replacement of the radio card in the wrong configuration will cause permanent damage to the radio card and/or monitor hardware.

The following service screens illustrate the 2.4 GHz radio card and the 5 GHz radio card diagnostic information.

Network Status screen (2.4 GHz radio card)

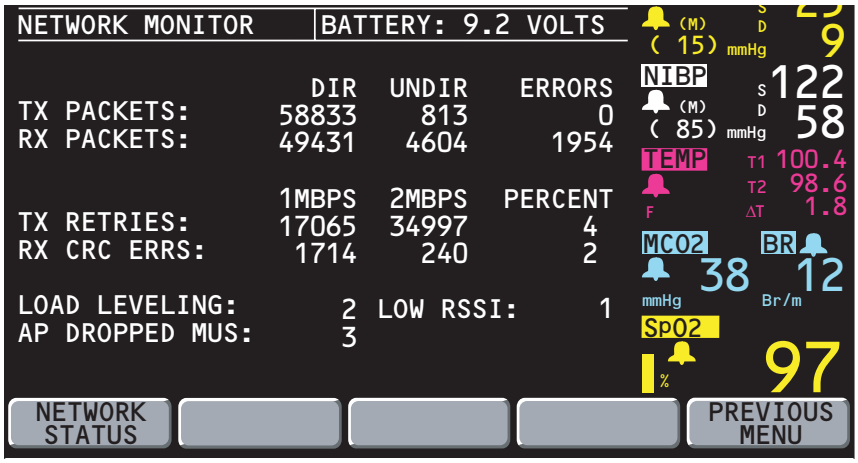
To access this screen, from the Main Menu press **SETUP > MORE > MORE > SERVICE > YES > MORE > MORE > RADIO STATUS**.



Network Monitor screen (2.4 GHz radio card)

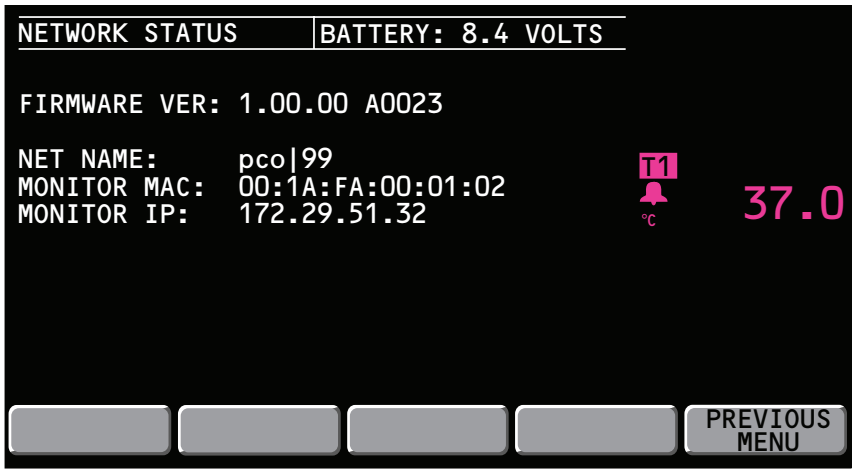
To access this screen, from the Network Status screen press **NETORK MONITOR**.

(Or from the Main Menu, press **SETUP > MORE > MORE > SERVICE > YES > MORE > MORE > RADIO STATUS > NETWORK MONITOR**.)



Network Status screen (5 GHz radio card)

To access this screen, from the Main Menu press **SETUP > MORE > MORE > SERVICE > YES > MORE > MORE > RADIO**.



Note Before the monitor has made a connection to the network, the fields in the above screen will not be populated. Once the fields are populated, they will not be updated until the monitor's power is cycled.

Note There is no 5 GHz Network Monitor service screen.

3 Functional verification

Introduction

This functional verification procedure helps to confirm the proper operation of the Propaq CS monitor and options. This procedure supports the requirements of routine preventive maintenance. No monitor disassembly is required to perform this procedure.

"Calibration" on page 43 provides the full calibration procedures. Calibration may be required if the monitor fails certain functional tests or after a circuit board is replaced. Monitor disassembly is required for calibration.

Always perform this functional verification procedure after performing any calibration. This procedure contains additional tests that are not included in calibration procedures.

The monitor Service Menus provide access to internal software routines that are required during the functional verification procedure. Service Menus provide features to test and verify the NIBP (cuff) channel, display, invasive pressure channel, and printer. Refer to "Overview" on page 5 for information about the Service Menus.

Self tests

Many functions, such as alarms, waveform and scale sizing, and printer control, are software operations. During the monitor's power-up self-test, the integrity of all programming is checked first. If software testing is successful, hardware tests are initiated. If all testing is successful, the monitor is ready for use. (See "Screen messages" on page 55 for information on error messages.)

Required equipment

You will need the following equipment to verify that all functions of the monitor operate correctly. All test equipment must be calibrated to function within parameters specified by the manufacturer, and must be traceable to a national calibration standard.

Some equipment can be manufactured. See "Manufacturable test equipment" on page 135 for information on manufacturable test equipment.

Description
Luer connector, male, for use with 1/8" I.D. tubing (Value Plastics, MTLL230-1)
Luer connector, female, for use with 1/8" I.D. tubing (Value Plastics, FTLL230-1)
Test water trap, Welch Allyn, 008-0370-00
1/8" inside diameter tubing
Flow meter, Cole Parmer E 32000-06, 200ml/min. or equivalent
0 to 300 mm Hg calibrated digital pressure meter, with inflation squeeze bulb (Netech, Digamano, or equivalent)
50 MHz triggered sweep oscilloscope
Variable dc power supply, 0-28 V, 3A with voltage and current metering
Patient simulator, Fluke (Dynatech/Nevada) 213A, 214A, 215A, or 217A with IBP, Temperature, and EGG Cable/Leads
Adult cuff (provided with monitor); Neonatal cuff #3; 3 cm diameter solid cylinder; solid cylindrical object about the size of an adult's arm
Welch Allyn cuff calibration kit, Welch Allyn PN 008-0012-XX
Power supply adapter cable, Welch Allyn PN 008-0290-00
Physio-Control LIFEPAK 5 or LIFEPAK 6s with appropriate Welch Allyn Defib Sync adapter to use as Defib Sync Marker pulse source
Propaq ac power adapter (provided with the monitor)
Safety analyzer, Fluke (Dynatech/Nevada), 431F-1D or equivalent
Rod-L Model M100AVS5 high-voltage potential (hi-pot) tester, or equivalent
Static-free work area
SpO_2 Simulator, Fluke (Biotek) Index 2 XL/XLFE
Test gas source: dry 4% to 10% CO_2, balance air (with flow meter). Gas may be between 4% and 10%, but exact CO_2 concentration must be certified to ±0.01. (Convert percentage to partial pressure (mm Hg) as instructed in "Partial pressure of test gas source" on page 31.)[a]
Two rubber test tube stoppers, with 1/8" to 1/4" holes drilled through (for CO_2 tests)

a. Of the gas tolerance available, usually described as ±0.03% absolute, the container must contain at least 2,000 psi grams of gas, to be within ±0.01% of the certified percentage of gas stated on the tag supplied by the vendor. The actual percentage of gas in the container may vary from lot to lot.

Safety tests

The following two safety tests, a risk (leakage) current safety check and a dielectric strength integrity (hi-pot) test, must be performed whenever the monitor has been opened for calibration or repair.

Note A hi-pot test is only required if the monitor has been opened.

Risk (leakage) current test

A risk (leakage) current test must be performed to verify that the patient remains electrically isolated from the power circuits of the monitor.

Check leakage currents using a Fluke (Dynatech/Nevada) 431F-1D safety analyzer or its equivalent. The source current should not exceed 10μA rms. The sink current, measured between the isolated patient connections (ECG) and the dc power input connector of the monitor, should not exceed 20μA rms. See the analyzer's operator's manual for the proper safety check procedure.

Note Because of the all-insulated construction of the monitor, an Enclosure Leakage Current Test to ground is not necessary.

Table 3. Electrical connections for patient risk (leakage) current safety tests

Safety test	Power adapter	Monitor dc input	Monitor cable	Safety analyzer
Source current	Plugged into analyzer outlet (power adapter switch on)	Connected to power adapter	RA LA LL C RL	RA LA LL C RL
Sink current	Not used	Connected to ground connector on analyzer	RA LA LL C RL	RA LA LL C RL

Dielectric strength (Hi-Pot) test

Because of the close spacings of the monitor's internal components and the critical positioning of the insulation sheet within the monitor, Welch Allyn recommends that a dielectric strength test be performed following any procedure in which the monitor is opened.

WARNING The Hi-Pot test is extremely hazardous. Only qualified service personnel should perform this test. Conduct the test only on an insulated table top, away from other people and equipment.

Use a Rod-L Model M100AVS5 high-voltage potential tester, or equivalent. Refer to the Rod-L instruction manual for operating information and safety recommendations.

1. Set the parameters of the high voltage tester per the ECG input connector specifications in the table below.

Table 4. Summary of connection points and high-voltage test parameters

Tester's high-voltage terminal connection	Tester's grounded return connection	High-voltage test parameters
ECG Input Connector: all ECG leads connected together	DC input connector; all pins connected together	Output: 4000 V ac rms Current Limit: 2.5 mA Ramp-up: 8 seconds Dwell: 1 second
Nurse Call Output Connector: Pins 1 and 3 connected together (use 008-0634-XX cable)	DC input connector; all pins connected together	Output voltage: 1500 V ac rms Output Current Limit: 2.5 mA Ramp-up: 8 seconds Dwell time: 1 second

2. Connect the high-voltage output lead of the tester to all ECG leads, using a dedicated patient cable reserved for use only in such tests.
3. Connect the tester's chassis-connected return lead to the monitor's dc input connector, using a suitable plug.
4. Apply the test voltage for one second. The tester must not indicate dielectric breakdown.

WARNING If any dielectric breakdown occurs, do not use the monitor. All internal sheet insulation barriers must be properly installed. Check the monitor to determine the cause of dielectric breakdown; then repair the monitor or return the monitor to Welch Allyn for repair.

If the monitor has the Nurse Call Option, continue with steps 5 to 8:

5. Remove the ECG connection from the monitor and the tester’s high voltage output lead.
6. Set the parameters of the high-voltage tester per the Nurse Call Output Connector in the table “Summary of connection points and high-voltage test parameters” on page 16 (be sure to **reduce** the test voltage).
7. Connect a 008-0634-XX Nurse Call Cable to the Nurse Call Output Connector on the monitor. Connect the open pins 1 and 3 of the cable to the high voltage output lead.
8. Apply the test voltage for one second and check that the tester does not alarm.

Functional verification

Perform the functional verification with the monitor fully assembled. If the monitor has been stored for longer than one month without the monitor connected to the ac adapter (for recharging), the battery voltage must be checked. The battery must be replaced if it cannot hold a charge. Refer to "Battery capacity check" on page 57.

Note See *Update to Directions for Use*, software version 3.6X and greater, for changes to patient alarms and equipment alerts.

Impedance pneumography (RESP) is an optional feature. Ignore references to RESP in this procedure if it is not installed.

If you plan to use a Fluke (Dynatech/Nevada) model 213A, 215A, or 217A Patient Simulator to simultaneously simulate ECG and invasive blood pressure, see "Fluke patient simulator modification" on page 137 for important information.

Before starting the verification procedure, charge the battery for at least 8 hours with the monitor turned off. (Charge for 12 hours if a printer or SpO_2 module is attached.)

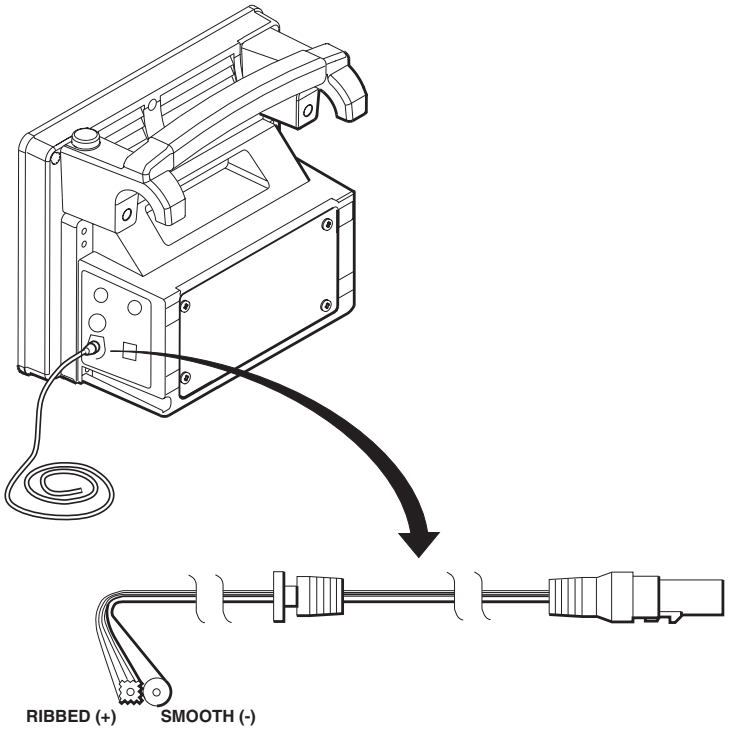
Power system

The following steps check the integrity of the monitor's power system.

1. Turn the ac power adapter's power switch off.
2. Plug the ac power adapter into an ac mains receptacle and connect it to the monitor's right side panel dc power connector.
3. Check that the green LED charging indicator on the monitor's right side panel is off.
4. Turn on the power adapter's power switch.
5. Check that the green LED on the power adapter turns on and that the green LED charging indicator on the monitor's right side panel turns on.
6. Disconnect the power adapter from the monitor. Check that the monitor's green LED charging indicator on the right side panel turns off.

Caution In the next steps, carefully check for proper polarity of the connection between the power supply and monitor. If voltage is applied with the wrong polarity, it will open the right side panel fuse (F1). Refer to the figure below to verify proper polarity.

7. Set the dc power supply meter to Volts and turn the power switch on; set it for 15.0V ± 0.1V.
8. Turn off the dc power supply.
9. Using the Welch Allyn dc power supply adapter cable, refer to the figure below for polarity and connect the dc power supply to the monitor's dc input connector on the right side panel.



10. Turn on the dc power supply.
11. Check that the green LED indicator lights up.

Note Initial charge current for a low battery is higher than for a charged battery. As the battery charges, the current will decrease. The current draw may slowly drop the longer the dc supply is connected to the monitor.

12. Switch the dc power supply meter to current and check that the current draw from the supply is less than 1.8 A.
13. Vary the power supply from 12 V to 28 V and verify that the charging LED stays on.
14. Turn off the power supply.
15. Disconnect the supply from the monitor.

System tests

The following procedures check that the buttons operate properly, that the display works correctly, and that the date is correctly displayed.

1. Turn on the monitor.
2. Verify that no error messages appear and the monitor correctly powers up.
3. Press **SETUP > MORE > MORE > SERVICE > YES > MORE > MORE > SCREEN CAL** and press **CALIBRATE** to perform the touch screen calibration. Press each corner in the location prompted to complete the screen calibration.
4. Press **KEY 0** through **KEY 4**, the **NET OFF** key, and the three icon-labeled keys along the right side of the display (Silence/Resent (software version 3.6x and greater) Alarm Suspend/Resume (all other software versions), NIBP Start/Stop , and Home). Confirm that the correct key press is displayed in the LAST KEY PRESSED area of the display.
5. Check the display for stable imaging.
6. Press **PREVIOUS MENU** to exit the Screen Cal menu.
7. Press **MORE > MORE > PIXEL TEST** to access the Pixel Test.
8. Check for stable screen and no missing pixels or other display problems during each of the following steps.
9. Press the following keys in sequence while observing the right side of the display to confirm the appropriate patterns appear: CHECKER 2, SOLID, and CHECKER 1. Also confirm that a thin line appears around the left side of the display.
10. Change the pattern back to SOLID, then press **RGB** to cycle through green, blue, white, black, and red colors. Confirm the colors are displayed properly.
11. Press **LEFT** and repeat the previous two steps for the left side of the display. Then press **PREVIOUS MENU** to exit the Pixel Test.
12. Press **HOME** **> SETUP > WAVE SELECT > INSERVICE** to access the inservice features. This generates simulated waveforms.
13. Press **HOME** to return to the Main Menu.
14. Press the following keys in sequence and verify that the monitor responds as indicated.

Table 5. Keystrokes and monitor responses—Software versions 3.6x and greater

Press	Result
SETUP	Changes the menu.
ALARMS	Changes the display to ALARM STATUS.
4 MIN SUSPND (on menu at bottom of screen)	4 MIN SUSPND changes to RESUME.
Silence/Reset button (software version 3.6sx and greater) or Alarm Suspend/Resume (software version 3.5x and earlier).	RESUME changes to 4 MIN SUSPND.
LIMITS	Changes display to ALARM Limits.
NEXT PARAMETER	Moves cursor block down - Next block in parameter limits
NEXT SETTING	Moves cursor block between upper and lower setting.
Home button	Returns to the Main Menu.
NIBP Start/Stop button twice	Starts/stops the NIBP pump.

Table 6. Keystrokes and monitor responses—All other software versions

Press	Result
SETUP	Changes the menu.
ALARMS	Changes the display to ALARM STATUS.
SUSPEND (on menu at bottom of screen)	SUSPEND changes to RESUME.
Silence/Reset button (software version 3.6sx and greater) or Alarm Suspend/Resume (software version 3.5x and earlier).	Toggles Suspend/Resume alarms.
ALL ALARMS (then press NO)	Changes display. Turn ALL OFF. Are You Sure? Y or N.
LIMITS	Changes display to HR Limits.
NEXT PARAMETER	Moves cursor block down - Next block in parameter limits.
NEXT SETTING	Moves cursor block between upper and lower setting.
Home button	Returns to the Main Menu.
NIBP Start/Stop button twice	Starts/stops the NIBP pump.

15. Press **ECG/RESP > MORE**. Then press **CHANGE** to select the four **HR/PR TONE** levels. Verify that the tone volume changes and goes off when turned OFF. Set the volume to LOW or OFF.
16. Press **HOME** to return to the Main Menu.
17. *Software versions 3.6x and greater:* Press **SETUP > MORE > MORE > SERVICE > YES > MORE > MORE > SETTINGS > ALL ALARMS**. Verify alarm status displays "TURNING OFF ALL AUDIBLE VITAL SIGNS ALARMS", "ARE YOU SURE?", YES or NO.
18. *Software versions 3.6x and greater:* Press **HOME** to return to the Main Menu.
19. Press **SETUP > MORE > MORE** and check that the displayed time and date are correct.

If incorrect, press **NEXT** and **UP** or **DOWN** to select and change the time and date. Then enter the new setting by pressing the **ENTER** key.

20. Turn off the monitor.

ECG/RESP Channel and Alarm Indicators

The following procedures verify the ECG channel and the alarm indicator drivers. The setup procedure below is used for both the visual and the electrical checks that follow.

Setup

1. Turn on the monitor and verify that it powers up correctly.
2. Put the monitor into FACTORY ADULT MODE by pressing **SETUP > MORE > CHANGE > SETUP > USE NOW > YES**.
3. Press **HOME** to return to the Main Menu.
4. Set the patient simulator as follows:
   - ECG Waveform: normal sinus rhythm
   - ECG Rate: 80 beats per minute (bpm)
   - ECG Size: 1 mV amplitude
   - Resp Lead: Lead I
   - Resp Baseline Impedance: 1 KΩ
   - Resp Rate: 40 breaths/minute (br/m)
   - Resp Breath Amplitude: 1.0Ω
5. Set the monitor as follows:
   - Respiration Lead: Lead I (**ECG/RESP**, **MORE**; select lead and change as necessary)
   - ECG Lead: Lead II (**ECG/RESP**, **ECG LEAD**)
   - ECG Size: 1 mV (**ECG/RESP**, **ECG SIZE**)
   - Resp Size: 8X (**ECG/RESP**, **RESP SZE**)
   - Respiration ON (**ECG/RESP**, **MORE**; select and set RESP to **ON**)
   - ECG Sweep: 25 mm/Sec (**SETUP**, **MORE**; select and change HR/PR sweep as necessary)
   - Alarms *(software versions 3.6x and greater):* Set alarm limits to OFF for HR/PR and RR/BR (**SETUP > ALARMS > LIMITS > ON/OFF > NEXT SETTING > ON/OFF > NEXT PARAMETER > ON/OFF > NEXT SETTING > ON/OFF**. Press **HOME** . The ALARM(S) OFF light will turn on, indicating that one or more alarm limits have been disabled.
   - Alarms: *(all other software versions):* All alarms OFF (**SETUP > ALARMS > ALL ALARM**. Press **YES** when prompted until all alarms are off except for the Apnea alarm, which cannot be turned off. The ALARM(S) OFF light will turn on, indicating that one or more alarm limits have been disabled.

- Audible vital signs alarms *(software versions 3.6x and greater)*: OFF (**SETUP > MORE > MORE > SERVICE > YES > MORE > MORE > SETTINGS > ALL ALARM > YES**. The ALARM light will turn on, indicating that the patient alarms are suspended.

6. Connect the ECG channel to the patient simulator using all five ECG leads.

Part 1— Visual check

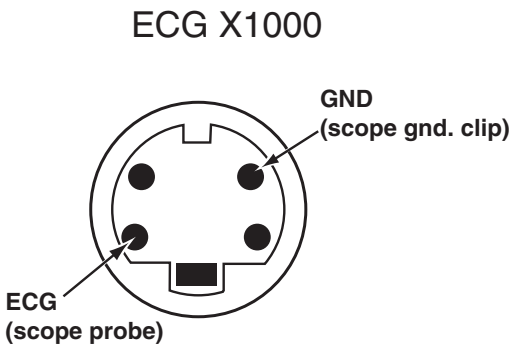
1. Press **HOME** to return to the Main Menu.
2. Press **ECG/RESP** to display the RESP waveform.
3. Check that a normal sinus rhythm ECG waveform is displayed. There should be a soft beep tone with each QRS event.
4. Check that the monitor's heart rate display is 80 ± 4 bpm and the respiration rate is 40 ± 2 bpm before proceeding to the next step.
5. Disconnect the LA ECG lead wire from the simulator.
6. Check that an equipment alert occurs. The EQUIPMENT ALERT / ECG FAULT message should accurately indicate the removed lead. The ALARM(S) OFF light will flash.
   - *Software versions 3.6x and greater:* The ECG FAULT will be displayed at the top of the screen.
   - *All other software versions:* The ECG FAULT and RESP FAULT will alternate at the top of the screen. An equipment alert audible alarm will sound; one second on, four seconds off.
7. Press any key to acknowledge. Check that the ALARMS(S) OFF light is on and no longer flashing.
8. Disconnect the LL ECG lead from the simulator.
9. Check that an equipment alert occurs. The ECG FAULT and RESP FAULT will alternate at the top of the screen. The ALARMS(S) OFF light will flash.
   - *Software versions 3.6x and greater:* The EQUIPMENT ALERT - MULTIPLE message should be displayed.
   - *All other software versions:* The EQUIPMENT ALERT / ECG FAULT / MULTIPLE LEAD FAIL message is displayed.
10. Press any key to acknowledge. Check that the ALARMS(S) OFF light is on and no longer flashing.
11. Reconnect the LL ECG lead, and then LA ECG lead.
12. Check that the ALARM(S) OFF light is on.
    Software version 3.6x and greater: Check that the ALARM light is on.
13. Check that the monitor’s heart rate display is 80 ± 4 bpm, and the respiration rate is 40 ± 2 bpm before proceeding to the next step.
14. *Software version 3.6x:* Press **SILENCE/RESET** to enable alert and alarm tones. Check that the ALARM light is off.
    All other software versions: Press **SETUP > ALARMS > ALL ALRM** to turn all alarms ON.

15. Press **HOME** **> SETUP > ALARMS > STAT SET** to automatically set heart and respiration rate alarm limits.
16. Check that the ALARM(S) OFF light is off.
17. Set the patient simulator heart rate to 180 bpm or higher.
18. Check that an alarm violation occurs, causing the tone to sound and the ALARM light to flash.
19. *Software versions 3.6x and greater:* Press **4 MIN SUSPND** and verify that the tone turns off and the ALARM light stops flashing.
    All other software versions: Press **ALARM SUSPEND/RESUME** and verify that the tone turns off and the ALARM light stops flashing.
20. Press **HOME** to return to the Main Menu.
21. Set the patient simulator heart rate to 80 bpm.
22. Check that the ALARM light is ON.
23. Press **SETUP > ALARMS > RESUME**.
24. Check that the ALARM light is OFF.
25. Press **HOME** to return to the Main Menu.

Part 2— Electrical check

Use the same setup for this check described in "Setup" on page 21.

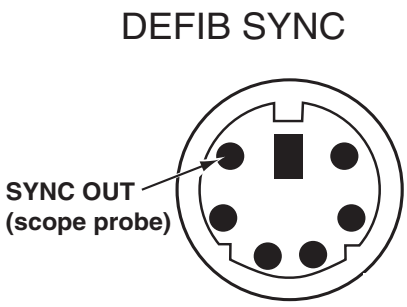
1. Set the patient simulator to provide pacer signals.
2. If the pacer indicator is not on, press **ECG/RESP, MORE** and select and change the pacer setting.
3. Check that a dashed vertical line is displayed on the ECG waveform each time a pacer pulse occurs.
4. Set the oscilloscope to 0.2 second/division sweep and 0.5 Volt/division amplitude.
5. Insert a short piece of thin conductive wire into each of the ECG X1000 connector holes shown in the figure below or use Real Time ECG out cable 008-0320-XX.



6. Connect the scope probe and the scope ground clip to the wires.
7. Check that the scope displays an ECG signal with an amplitude of 1 V ±100 mV baseline to peak of R-wave.

Note Some amount of mains noise may also be present in the signal.

8. Move the wire and scope probe from the ECG pin of the ECG X1000 connector to the DEFIB SYNC connector pin shown in the figure below or use Defib Sync Output cable, 008-0237-00. Leave the scope's ground clip where it is.



9. Change the vertical sensitivity of the scope to 1 Volt/division.
10. Check that the scope displays a 5 V p-p pulse with a 100 ±5 ms width.
11. Disconnect the scope probe and ground clip and remove the wires from the connectors.
12. Using either a LIFEPAK 5 or LIFEPAK 6s and appropriate Welch Allyn adapter, set up the monitor and defibrillator according to instructions provided in the *Defib Sync User's Guide*.
13. Check the monitor display for sync markers on the ECG waveform.
14. Disconnect the defibrillator from the monitor.

Note If the patient simulator does not also provide an appropriate ECG signal, the heart rate value will be displayed as "– – –" and an alarm violation will occur.

15. Disconnect the ECG cable from the monitor. (Disconnecting an active channel initiates an equipment alarm; press any key to acknowledge the discontinuance of ECG monitoring.)

IBP channel

The following procedure verifies the operation of the invasive blood pressure channels. Some models of the monitor have no IBP channels; skip this procedure if your monitor does not support IBP. If your monitor has multiple IBP channels, repeat the verification procedure for each channel.

Caution Many blood pressure simulators are not intended to be used as calibration standards. Use only the blood pressure simulators specified in "Required equipment" on page 14.

Note If you are using the Fluke (Dynatech/Nevada) model 213A, 215A, or 217A patient simulator, do not simultaneously monitor ECG and invasive blood pressure (IBP) unless the modification to the simulator is performed as described in "Fluke patient simulator modification" on page 137. If you do not wish to modify your simulator, use ECG and IBP independently.

1. Press **SETUP > WAVE SELECT** and check that the P1 and P2 waveforms are turned on.
2. Connect the IBP cable from the patient simulator to an IBP input jack on the left side panel of the monitor.
3. Set the simulator output pressure to 0 mm Hg.

Note If an alarm tone sounds, press **SILENCE/RESET** (software version 3.6x and greater) or **ALARM SUSPEND/RESUME** (all other software versions).

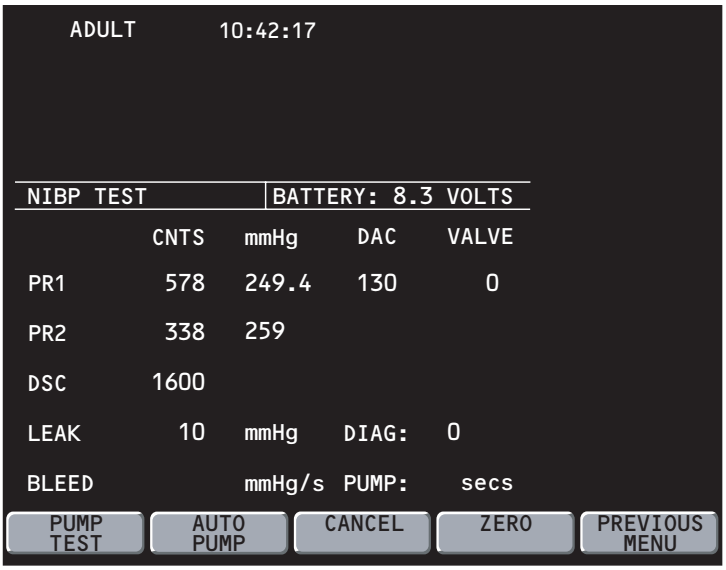
4. Zero P1 by pressing **ZERO P1**.
5. Check that ZEROED is displayed.
6. Press **RESCALE**.
7. Check for a noise level ≥ 3 mm on the IBP waveform.
8. After allowing a few seconds for settling, check that the mean pressure reading is 0 mm Hg ± 1 mm Hg.
9. Set the pressure simulator to 200 mm Hg.
10. After allowing a few seconds for settling, check that the mean pressure reading is 200 mm Hg ± 2 mm Hg.
11. Remove the cable from the P1 input jack and verify that the message: P1 FAULT - TRANSDUCER NOT DETECTED appears.
12. Press any key to acknowledge the discontinuance of IBP monitoring.
13. Press **HOME** .

NIBP

1. Connect the cuff, digital pressure meter, bulb, and the Encore together with the cuff calibration kit. Using T-connectors from the kit, connect the cuff, pressure meter, and bulb.
2. Connect this NIBP test setup to the pressure transducer at PT1 on the Analog board.
3. Wrap the adult cuff around the black tube volume or a cylindrical object about the size of an adult's arm.
4. Press **SETUP > MORE > MORE > SERVICE > YES > NIBP TEST > NIBP CAL**.

Note The NIBP CAL mode holds pressure for 10 minutes. If performing steps 4 through 9 takes longer than 10 minutes, press NIBP CAL again.

5. Close the valve on the bulb and inflate the cuff to 250 mm Hg as shown on the pressure meter.
6. Check that the readings (PR1 and PR2) on the monitor's display are 250 ±3 mm Hg (PR1) and 250 ±15 mm Hg (PR2), as shown below.



7. Manually reduce the pressure as indicated on the pressure meter to each of the levels shown in the following table, and check the displayed value of PR1 to be within the tolerance listed in the following table.

Pressure (mm Hg)	Tolerance (mm Hg)
270	±4
250	±3
200	±2
100	±2
50	±2
20	±2

8. Reduce the pressure to 0 mm Hg and check that the displayed readings (PR1 and PR2) are 0 ±2 mm Hg.
9. Close the bulb valve.
10. Press **CANCEL**. (If there is no CANCEL key at this time, go to the next step.)
11. Disconnect the adult cuff from the test setup and connect the neonatal cuff #3 that is wrapped around a solid 3 cm diameter cylinder.
12. Press **PUMP TEST**.
13. Check that the pump inflates the cuff to approximately 280 mmHg.
14. After four minutes, check that the displayed leakage is less than 50 mmHg.

Note If the leakage exceeds this specification, first check all exterior hoses and fittings before diagnosing an internal air leak problem.

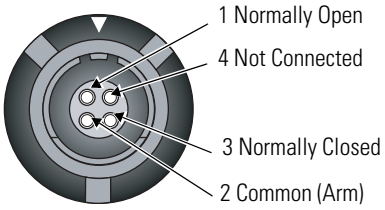
15. Press **HOME** .
16. Disconnect the cuff and Cuff Calibration Kit.

Temperature

1. Plug a 37.0° C YSI 400 series (two conductor) calibrated temperature probe simulator into the T1 jack on the monitor's left side panel.
2. Check that the T1 temperature is 37° ± 0.1° C.
3. Repeat Steps 1 and 2 for T2.
4. Plug a 37° C YSI 700 series (three conductor) temperature probe simulator into the T1 jack.
5. Check for 37° ± 0.1° C.
6. Repeat Steps 4 and 5 for T2.
7. Remove all connectors and turn the monitor off.

Nurse Call

1. With the monitor not in alarm mode, use an ohmmeter to check the contact resistance at the output pins of the Nurse Call connector. Confirm the values listed below in Column 2 (Alarm Off).



Nurse Call Connector on Monitor

Pins	Alarm off	Alarm on
1-2	> 1MΩ	< 1Ω
2-3	< 1Ω	> 1MΩ

2. From the Main Menu, press **SETUP > WAVE SELECT > INSERVICE** to select the in-service mode. This sets alarms on. Press **HOME** , then press **SETUP > WAVE SELECT > INSERVICE** to enable the second in-service mode which violates the HR alarm settings. Use an ohmmeter to confirm the values listed in Column 3 above (Alarm On).

SpO_2 checks

Functional verification for Masimo SpO_2

This functional verification procedure helps to confirm the proper operation of the Masimo Pulse Oximetry option installed in the Propaq monitor. This procedure supports the requirements of routine preventive maintenance. No monitor disassembly is required to perform this procedure.

You will need the following equipment to perform this procedure.

- Masimo-compatible SpO_2 cable.
- Compatible adult SpO_2 sensor for finger.
- BIO-TEK Index 2 Series SpO_2 Simulator with optical finger for sensor connection (or equivalent).

1. Turn on power to the SpO_2 simulator.
2. Connect the SpO_2 cable to the monitor and the SpO_2 sensor.
3. Apply the SpO_2 sensor to the SpO_2 simulator optical finger.
4. Set the simulator manufacturer type ("MAKE") to Masimo.
5. Set the simulator output to SpO_2 saturation 94% and pulse rate 60 beats per minute (with no motion artifact selected).

   Confirm that the monitor displays SpO_2 data and the pulse amplitude indicator is moving.

   Confirm that the displayed saturation is 94% ±4 counts, and the displayed pulse rate is 60 ±4 bpm.
6. Disconnect the sensor from the simulator and cable, and disconnect the SpO_2 cable.

Functional verification for Nellcor SpO_2

This functional verification procedure helps to confirm the proper operation of the Nellcor Pulse Oximetry option installed in the Propaq monitor. This procedure supports the requirements of routine preventive maintenance. No monitor disassembly is required to perform this procedure.

You will need the following equipment to perform this procedure.

- Nellcor-compatible adult SpO2 finger sensor
- BIO-TEK Index 2 Series SpO_2 Simulator with optical finger for sensor connection (or equivalent).

1. Turn on power to the SpO_2 simulator.
2. Connect the SpO2 sensor to the monitor and apply to the SpO2 simulator optical finger.
3. Set the simulator manufacturer type ("MAKE") to Nellcor.
4. Set the simulator output to SpO_2 saturation 94% and pulse rate 60 beats per minute (with no motion artifact selected).

   Confirm that the monitor displays SpO_2 data and the pulse amplitude indicator is moving.

   Confirm that the displayed saturation is 94% ±4 counts, and the displayed pulse rate is 60 ±4 bpm.
5. Disconnect the sensor from the simulator.

Sensor compatibility

Some sensors are not compatible with the particular Nellcor processing board installed in the Propaq. To determine which pulse oximetry optional processing board is installed in the Propaq, find the option number on the back label of the Propaq, then refer to table

"Expansion module option configurations" on page 8. The following table shows how to identify compatible sensors for each Nellcor option:

Table 7. Sensor compatibility

Sensor Description	Connector			Compatible with		
	Pins	Notches	Color	MP-203	MP-405	Nell-2, MP-507
Single-ended	7	0	Varies	Yes	No	No
Differential	7	1	Varies	Yes	Yes	No
OxiMax	9	2	Purple	Yes	Yes	Yes
OxiMax-Exclusive	8	2	White	No	No	Yes

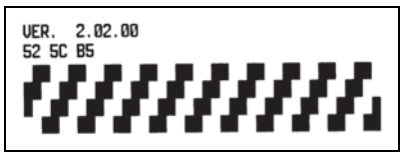
Printer tests

The following steps check the functionality of the printer.

Note Functional verification should be performed on the monitor before beginning the printer tests. The monitor must be functioning properly to perform printer tests.

1. Disconnect all cables from the monitor.
2. Turn the monitor OFF then ON.
3. Press **SETUP > WAVE SELECT > INSERVICE**.
4. Press HOME .
5. Wait at least 8 seconds and then press the printer's **SNAPSHOT** key.
6. Check that the printer prints an approximately eight-inch strip of the simulated patient data. The paper should stop only after the entire waveform has been fed out of the printer.
7. Press the printer's **START/STOP** key. The printer should begin continuous printing.
8. Press the **START/STOP** key to stop printing.
9. Lay the monitor on its back.
10. Press the **START/STOP** key to start printing.
11. Completely open the paper door on the bottom of the Expansion Module.
12. Check that the printer stops printing, and that an equipment alarm and CHECK DOOR message appear on the monitor screen.
13. Cut or tear the printer paper in the printer mechanism from the roll, leaving the strip of paper in the printer mechanism.
14. Completely close the paper door.
15. Press the **START/STOP** key.
16. After the printer runs out of paper, check that an equipment alarm and **PAPER OUT** message appear on the monitor screen.
17. Open the printer door and reload the paper into the printer.

18. Close the paper door and set the monitor upright.
19. Simultaneously press the **PRINT TRENDS** and **START/STOP** buttons.
20. Check that a test printout similar to one shown in the figure below is printed.



CO_2 verification preparation

The mainstream and sidestream CO_2 functional verification procedures require calculating the local barometric pressure and partial pressure of the test gas (in mmHg) to compare to monitor displayed values.

Local barometric pressure

The first step is to determine the local barometric pressure:

1. Determine local altitude above sea level.

   For worldwide locations, obtain altitude from local geological maps (U.S.G.S. maps in the United States) or other local references on the maps. Refer to the table titled: Uncorrected Barometric Pressure as Function of Altitude; use this table to determine the local uncorrected pressure (LUP).

2. Determine ATIS reported pressure (inches or millimeters of Hg).

   For U.S. locations, consult local telephone directories to obtain the Automated Terminal Information Service (ATIS) number, typically listed under United States Government Offices, Department of Transportation, Federal Aviation Administration, and Air Traffic Control Towers.

   Among various statistics reported is the "altimeter," which is given in four integers. The four digits represent the barometric pressure as referred to sea level, in units of inches of mercury, with an assumed decimal point occurring between the second and third numbers.

   For worldwide locations, equivalent altimeter statistics, in millimeters of mercury, may be obtained from local agencies.

Note The difference in altitude between the calibration site and the ATIS site should not be greater than 30 m or 100 ft.

3. Determine local barometric pressure using LUP and ATIS. Apply the ATIS and LUP values to the following formula to calculate the local barometric pressure (mmHg):

   Local Barometric Pressure =
   0.033421 x LUP x ATIS (ATIS in inches of Hg)
   0.00131579 x LUP x ATIS (ATIS in mm of Hg)

Example 1

a. The altitude is 5000 *feet*. The local uncorrected pressure (LUP) is determined from the following table to be 632.35.

b. The reported ATIS is 30.09 inches Hg. (Altimeter: three zero zero niner.)

c. Multiply the LUP (632.35) by the ATIS (30.09) times 0.033421.

This gives the local barometric pressure of 635.92 mmHg.

Example 2

a. The altitude is 1000 *meters*. The local uncorrected pressure (LUP) is determined from the following table to be 674.11.

b. The reported ATIS is 764.29 mmHg.

c. Multiply the LUP (674.11) by the ATIS (764.29) times 0.00131579.

This gives the local barometric pressure of 677.92 mmHg.

Partial pressure of test gas source

To determine the partial pressure of test gas source multiply the local barometric pressure (as determined in step 3 above) by the certified percentage (±0.01% accuracy) of the test gas.

Example

The local barometric pressure (as calculated in Example 1 above) is 635.92 mmHg.

The certified CO_2 gas percentage is 5.00%.

Determine the CO_2 partial pressure by multiplying (635.92) x (0.0500).

This gives the partial pressure of the CO_2 as 31.8 mmHg.

Table 8. Local uncorrected barometric pressure (LUP) as a function of altitude (feet)

Altitude (feet)	Pressure (mmHg)	Altitude (feet)	Pressure (mmHg)	Altitude (feet)	Pressure (mmHg)	Altitude (feet)	Pressure (mmHg)
-2000	816.56	1000	732.93	4000	656.38	10000	522.65
-1900	813.66	1100	730.27	4200	651.52	10333	515.93
-1800	810.76	1200	727.62	4400	646.68	10667	509.26
-1700	807.87	1300	724.97	4600	641.88	11000	502.69
-1600	804.99	1400	722.33	4800	637.10	11333	496.18
-1500	802.11	1500	719.70	5000	632.35	11667	489.72
-1400	799.25	1600	717.07	5200	627.64	12000	483.34
-1300	796.39	1700	714.46	5400	622.95	12333	477.04
-1200	793.54	1800	711.85	5600	618.28	12667	470.78
-1100	790.70	1900	709.25	5800	613.65	13000	464.60
-1000	787.87	2000	706.65	6000	609.04	13333	458.50
-900	785.05	2100	704.07	6200	604.47	13667	452.44
-800	782.23	2200	701.49	6400	599.92	14000	446.46
-700	779.42	2300	698.92	6600	595.40	14333	440.55
-600	776.62	2400	696.36	6800	590.90	14667	434.68

Table 8. Local uncorrected barometric pressure (LUP) as a function of altitude (feet) (continued)

Altitude (feet)	Pressure (mmHg)	Altitude (feet)	Pressure (mmHg)	Altitude (feet)	Pressure (mmHg)	Altitude (feet)	Pressure (mmHg)
-500	773.83	2500	693.80	7000	586.44	15000	428.89
-400	771.05	2600	691.26	7200	582.00	15333	423.17
-300	768.28	2700	688.72	7400	577.58	15667	417.49
-200	765.51	2800	686.18	7600	573.20	16000	411.89
-100	762.75	2900	683.66	7800	568.84	16333	406.35
0	760.00	3000	681.14	8000	564.51	16667	400.86
100	757.26	3100	678.63	8200	560.21	17000	395.44
200	754.52	3200	676.13	8400	555.93	17333	390.08
300	751.80	3300	673.64	8600	551.68	17667	384.76
400	749.08	3400	671.15	8800	547.45	18000	379.52
500	746.37	3500	668.67	9000	543.26	18333	374.34
600	743.67	3600	666.20	9200	539.08	18667	369.20
700	740.97	3700	663.73	9400	534.94	19000	364.13
800	738.28	3800	661.27	9600	530.82	19333	359.12
900	735.61	3900	658.82	9800	526.72	19667	354.15
1000	732.93	4000	656.38	10000	522.65	20000	349.24

Table 9. Local uncorrected barometric pressure (LUP) as a function of altitude (meters)

Altitude (meters)	Pressure (mmHg)	Altitude (meters)	Pressure (mmHg)	Altitude (meters)	Pressure (mmHg)	Altitude (meters)	Pressure (mmHg)
-700	825.23	1000	674.11	2700	546.23	4400	438.74
-650	820.43	1050	670.03	2750	542.79	4450	435.86
-600	815.65	1100	665.98	2800	539.37	4500	432.99
-550	810.89	1150	661.94	2850	535.96	4550	430.14
-500	806.15	1200	657.92	2900	532.58	4600	427.31
-450	801.43	1250	653.92	2950	529.21	4650	424.49
-400	796.74	1300	649.94	3000	525.85	4700	421.69
-350	792.07	1350	645.98	3050	522.52	4750	418.90
-300	787.43	1400	642.04	3100	519.20	4800	416.12
-250	782.80	1450	638.12	3150	515.90	4850	413.36
-200	778.20	1500	634.22	3200	512.62	4900	410.62
-150	773.61	1550	630.34	3250	509.35	4950	407.89
-100	769.05	1600	626.48	3300	506.10	5000	405.18
-50	764.52	1650	622.63	3350	502.87	5050	402.48
0	760.00	1700	618.81	3400	499.65	5100	399.79
50	755.51	1750	615.00	3450	496.45	5150	397.12

Table 9. Local uncorrected barometric pressure (LUP) as a function of altitude (meters) (continued)

Altitude (meters)	Pressure (mmHg)	Altitude (meters)	Pressure (mmHg)	Altitude (meters)	Pressure (mmHg)	Altitude (meters)	Pressure (mmHg)
100	751.03	1800	611.22	3500	493.27	5200	394.46
150	746.58	1850	607.45	3550	490.10	5250	391.82
200	742.15	1900	603.70	3600	486.95	5300	389.19
250	737.74	1950	599.97	3650	483.82	5350	386.58
300	733.35	2000	596.26	3700	480.70	5400	383.98
350	728.99	2050	592.57	3750	477.60	5450	381.39
400	724.64	2100	588.89	3800	474.51	5500	378.82
450	720.32	2150	585.24	3850	471.44	5550	376.27
500	716.01	2200	581.60	3900	468.39	5600	373.72
550	711.73	2250	577.98	3950	465.36	5650	371.20
600	707.47	2300	574.38	4000	462.33	5700	368.68
650	703.23	2350	570.80	4050	459.33	5750	366.18
700	699.01	2400	567.24	4100	456.34	5800	363.69
750	694.81	2450	563.69	4150	453.37	5850	361.22
800	690.63	2500	560.16	4200	450.41	5900	358.76
850	686.47	2550	556.65	4250	447.47	5950	356.31
900	682.33	2600	553.16	4300	444.54	6000	353.88
950	678.21	2650	549.68	4350	441.63	6050	351.46
1000	674.11	2700	546.23	4400	438.74	6100	349.05

Mainstream CO_2 verification procedure

This procedure verifies the accuracy of the monitor's mainstream CO_2 (MCO_2) measuring system. If verification test results exceed specification limits, calibration ("MSP Board (MCO2) calibration" on page 54) MAY or MAY NOT be required—there are multiple possible sources of errors in testing as listed in the table below.

1. Connect an MCO_2 sensor with airway adapter to the monitor MCO_2 input connector.
2. Turn on the monitor. Press **SILENCE/RESET** (software version 3.6x and greater) or **ALARM SUSPEND/RESUME** (all other software versions) to disable the alarms.
3. Press **SETUP > MORE > MORE > SERVICE > YES > MORE > MORE > SETTINGS** and then set the CO_2 measurement units to millimeters of mercury (mmHg).
4. Allow the monitor and sensor to warm up for at least 15 minutes.

Note Possible errors may be caused if the area has high background CO_2 levels or if CO_2 has been forced outside of the airway adapter and into the sensor itself. To reduce the background CO_2 level, the area should be well ventilated and, preferably, the technician should be the only person present. If CO_2 has been forced into the sensor, allow 24 to 48 hours for the CO_2 to dissipate.

5. After 15 minutes, verify that the CO_2 reading (of ambient room air) on the monitor display is 1 mmHg, ±1 mmHg.
6. Install a rubber stopper in each end of the sensor airway adapter. (Refer to "Required equipment" on page 14.)
7. Connect the CO_2 gas source through the hole in the stopper on one end of the airway adapter. Leave the other end open.

Note Before performing the following steps, convert the percentage of the gas source to partial pressure (mmHg) according to the procedures in Mainstream "CO2 verification preparation" on page 30.

8. Introduce a flow of test CO_2 at a rate of 60 to 200 ml/min into the sensor airway adapter.
9. For test gas calculated partial pressure values of 30 mmHg or less, check the CO_2 reading on the monitor display to be within 3 mmHg.
10. For test gas calculated partial pressure values greater than 30 mmHg, check the CO_2 reading on the monitor display to be within ±10% of the partial pressure value.

Note If CO_2 test results are out of specification limits, check the table below for possible error sources. Always verify the test setup to minimize errors.

11. Disconnect the test gas source and other test equipment.
12. Disconnect the CO_2 sensor from the monitor.
13. Turn off the monitor.
14. Log the test date and results in your department log.

WARNING Eliminate all the possibilities causing errors shown in the following table before performing the calibration procedure ("MSP Board (MCO2) calibration" on page 54). Recalibrating the altimeter as described in that procedure, without adequately eliminating all other possible faults, may result in inaccurate $EtCO_2$ readings.

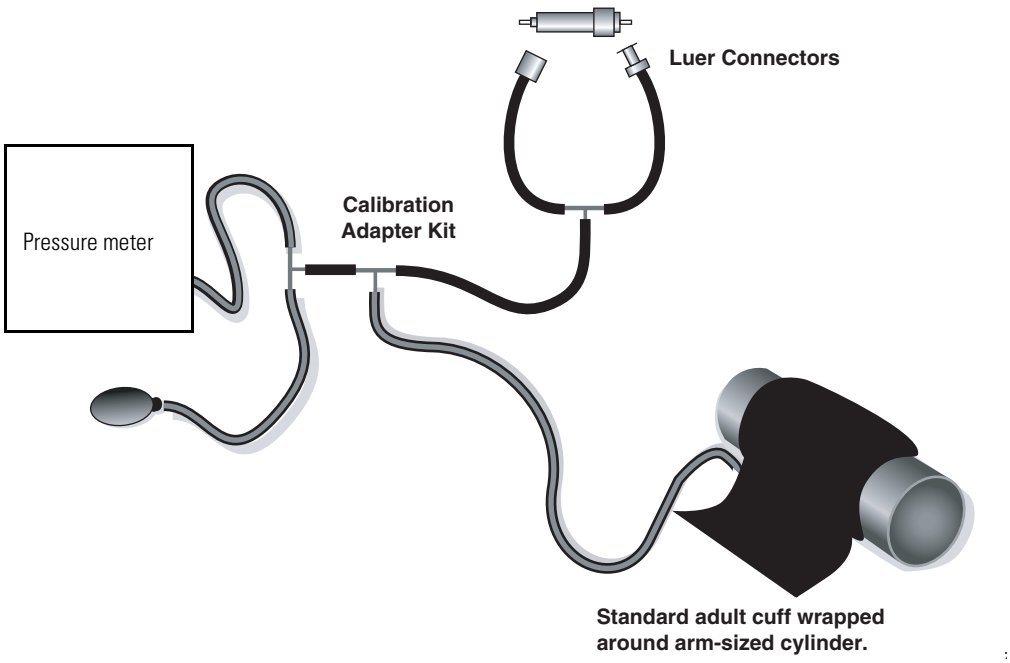
Table 10. Possible sources of CO_2 verification test errors

Error	Specification	Correction
Incorrect/unknown calibration gas concentration	4 to 10% certified to within ±0.01%	Verify gas supply. Gas must be between 4% and 10%. Once known, convert percentage to partial pressure (mmHg) as instructed in "Partial pressure of test gas source" on page 31.
Insufficient/excessive gas flow rate	Between 60 and 200 ml/min	Verify with flow meter.
Excessive back pressure in cuvette	Back pressure should not exceed 1 mmHg	Connect gases as instructed in verification test.
Air mixed with standard gas		Check integrity of test setup.
Gas temperature	Gas temperature entering airway adapter should be at room temperature	Store gas at room temperature.
Cuvette error	Results should not vary more than 0.5 mmHg due to cuvette tolerances	Use another cuvette (airway adapter).
Thermal equilibrium error	Sensor not warmed up	Allow the sensor/system to warm up for 15 minutes.
High CO_2 reading with sensor subject to room air only	CO_2 forced outside of airway adapter into sensor. This is possible during demonstration if exhaled gases are blown through hands cupped around cuvette and exhaled gases are forced into sensor.	Contain exhaled breath through the inside of the cuvette only. Do not allow gases to be forced outside of the cuvette and into the sensor housing. If CO_2 has been forced into the sensor, allow 24 to 48 hours for the CO_2 to dissipate.

Sidestream CO_2 verification procedure

The following procedures verify the operation of the sidestream CO_2 (SCO_2) option.

1. Allow the monitor to warm-up for 3 minutes before performing the SCO_2 tests.
2. If present, disconnect the mainstream sensor from the monitor.
3. If installed, remove the water tap from the receiver on the front left panel of the expansion module.
4. Determine the local barometric pressure as instructed in "CO2 verification preparation" on page 30, steps 1-3.
5. Select the SIDE TST screen through **SETUP > MORE > MORE > SERVICE > YES > CO2 TEST.**
6. Verify that BARO TRUE and INT are within 15 mmHg (5 mmHg, typical) of the barometric pressure determined in step 4.
7. Connect the test tubing setup shown in the figure below to both ends of a test water trap.



8. Use the pump bulb to manually inflate the pressure to 100 mmHg as read on the pressure meter.
9. Wait 15 seconds for the pressure to stabilize. Note the pressure reading, then wait an additional 60 seconds and check that the pressure has not dropped more than 10 mmHg. (Replace the water trap and retest if the leak rate is over 10 mmHg.) Record the leak rate value for use in step 17 below.
10. Disconnect the water trap from the test setup and install it into the water trap receiver of the monitor under test. Wait for SRCH to appear in the SCO_2 numerics window.

11. Plug the water trap inlet and verify that the monitor generates an OCCLUSION-CHECK WATER TRAP/TUBING equipment alert message. Acknowledge the equipment alert. Wait for SRCH to appear in the SCO_2 numerics window.
12. Plug the exhaust port and verify that the monitor generates an OCCLUSION-CHECK EXHAUST PORT/TUBING equipment alert message. Acknowledge the equipment alert.

Caution The occlusion test can stress any defective pneumatic tubing connections and may cause leakage. Always perform the following leak test after the occlusion test to reveal any tubing problems.

13. Through the **CO2/SPO2 > CO2 > MORE** menu, push **SOURCE** to turn off CO2/BR monitoring. Confirm the message.
14. Connect the test tubing setup as shown above to the water trap inlet and to the exhaust port.

Caution Do not exceed 100 mmHg during the following pressurization. Excessive pressure can open internal tubing connections and cause leakage.

15. Use the pump bulb to manually inflate the pressure to 100 mmHg.
16. Wait 15 seconds for the pressure to stabilize. Note the pressure reading, then wait an additional 60 seconds and record the leak rate. This is the total leakage (including water trap leakage from step 9).
17. Subtract the water trap leakage (determined in step 9) from the total leakage (determined in step 16) to obtain the internal SCO_2 leak rate which should be less than 10 mmHg. The total leakage, including water trap leakage from step 9, cannot be more than 10 mmHg.
18. Disconnect the tubing setup from the water trap and exhaust port.
19. With water trap installed in the water trap receiver, turn on SCO_2 monitoring through **CO2/SPO2 > CO2 > MORE > SOURCE**.
20. Through the **CO2/SPO2 > CO2 > MORE > FLOW RATE** menus, set the monitor flow rate to 90 mL/min.
21. Wait 5 minutes.
22. Connect the flow meter to the water trap.
23. Check that the measured flow rate is between 76 and 104 mL/min.
24. Disconnect the flow meter from the tubing connected to the water trap (leave the open length of tubing connected.)
25. Connect the flow meter in line with the CO_2 gas delivery tubing.
26. Adjust the CO_2 flow for a rate of 110-200 mL/min.
27. Insert the gas delivery tubing and the open sampling line from step 24 into a small ziplock bag (sandwich sized) with the zip lock closed as far as possible without pinching the tubing. This will slightly pressurize the bag with the test gas.
28. Wait two minutes for the bag to fully equalize with the test gas.
29. Calculate the partial pressure of the test gas used as instructed in "CO2 verification preparation" on page 30.

30. Multiply the calculated partial pressure (in mmHg) from step 29 by 0.95316. Record this calculation for use in step 33.
31. Select the SIDE TEST through the **SERVICE > CO2 TEST > SIDE TEST** menus.
32. Observe the instantaneous CO_2 value on the service screen for a constant value indicating that the CO_2 concentration in the ziplock bag has stabilized.
33. Check that the observed instantaneous CO_2 value is within 3 mmHg or 10%, whichever is greater, of the calculated value from step 30 (round up all half values on the service screen to the next higher mmHg).
34. Disconnect the test setup.

Functional verification for the Acuity option

This functional verification procedure helps to confirm the proper operation of the Propaq CS monitor with the hardwired or wireless Acuity communications option. This procedure supports the requirements of routine preventive maintenance. No monitor disassembly is required to perform this procedure.

Functional verification for Acuity Hardwired option

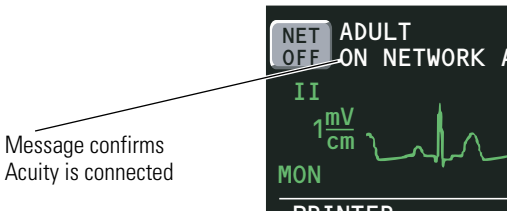
You will need the following equipment to perform this procedure.

- Acuity network cable.
- Access to Acuity network jack connecting to a properly functioning Acuity FlexNet network.

1. Disconnect any patient cables connected to the monitor. Make sure the hardwire Acuity network cable is not plugged into the Acuity network jack on the right side of the monitor.
2. Turn the monitor off, then turn it on.
   - Confirm that a powerup screen with the model number appears for a few seconds, followed by the Main Menu with no error messages.
   - If the monitor does not powerup properly, contact Welch Allyn Technical Support for assistance.
3. Plug the Acuity network cable into the Acuity network jack on the monitor. Plug the other end of the cable to the bedside Acuity network jack.
4. Confirm that after a short time (less than a minute), the monitor displays the following message:

   ON NETWORK

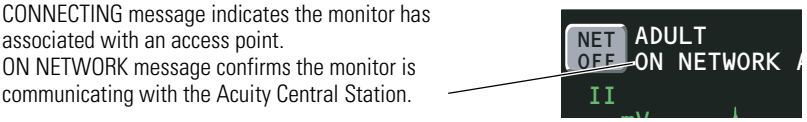
   If the monitor has wireless capability, confirm that the message ON NETWORK alternates with SERIAL.



Functional verification for Acuity Wireless option

To perform this procedure, you will need access to a properly functioning Acuity FlexNet network supporting wireless operation.

1. Disconnect any patient cables connected to the monitor. Make sure the hardwire Acuity network cable is not plugged into the Acuity network jack on the right side of the monitor.
2. Turn the monitor off, then turn it on.
   - Confirm that a powerup screen with the model number appears for a few seconds, followed by the Main Menu with no error messages.
   - If the monitor does not powerup properly, contact Welch Allyn Technical Support for assistance.
3. Confirm that within a few seconds the monitor displays the alternating messages CONNECTING and WIRELESS (this may be for only a few seconds or less). The CONNECTING message indicates the monitor has associated with an Access Point (AP).
4. Confirm that after a short time the monitor displays the alternating messages ON NETWORK and WIRELESS.


CONNECTING message indicates the monitor has associated with an access point.
ON NETWORK message confirms the monitor is communicating with the Acuity Central Station.
NET
OFF
ADULT
ON NETWORK
II

   - The monitor displays the ON NETWORK message near the beginning of the "rendezvous" process of establishing connection with Acuity. When Acuity displays patient data from the monitor, the rendezvous process is complete.
5. Gain access to the Network Status screen. (From the Main Menu, press **SETUP > MORE > MORE > SERVICE > YES > MORE > MORE > RADIO STATUS**.)
6. Observe the RSSI.
   - RSSI is an indicator of the inverse relative signal strength (a lower number indicates a higher signal strength). Although the monitor and Acuity can maintain communication for RSSI as great as 64, the WLAN network design allows for typical RSSI to be in the range of 30 (near an AP) to 55 (far away from an AP). Be aware that the RSSI for monitors in identical locations can vary as much as 5.
   - RSSI is only valid when the monitor is associated with an AP and packets are being received from Acuity (see Network Status screen, PSICP RX:). When not associated or first associated, the monitor can report RSSI as high as 99.

Note RSSI is not displayed on 5 GHz radio card-equipped monitors.

7. Observe the Network Status screen and confirm that a Monitor IP address is displayed.

Reset Radio menu (5 GHz radio card)

For monitors containing a 5 GHz radio card, a concealed menu is provided that allows resetting the 5 GHz card's configuration back to its factory default configuration. It may be necessary to return the radio card to its default settings if:

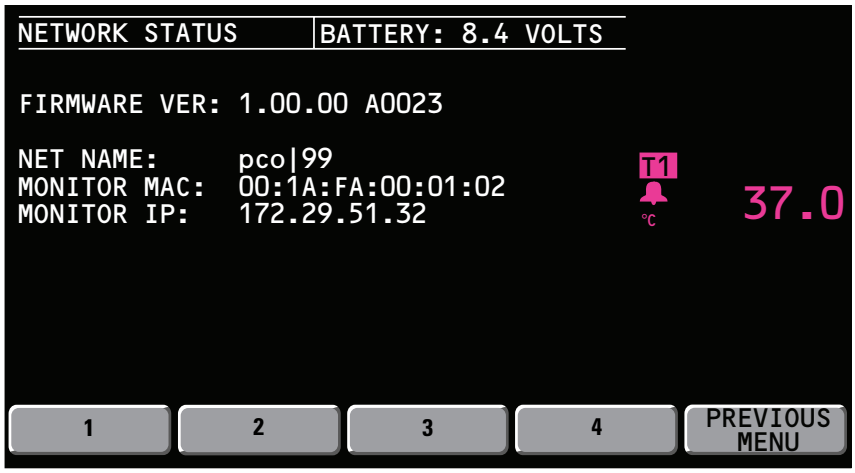
- The wireless network parameters or security key were updated incorrectly
- A network security setting was enabled that is not supported by the network infrastructure
- The network name was changed incorrectly
- The default password was changed and forgotten

The Radio Card Configuration Reset screen can only be entered under the following conditions:

- The monitor is equipped with a working 5 GHz radio card
- There is no Acuity connection active (Network status is set to OFF)
- The 5 GHz radio card has finished its initialization and is ready to accept the Reset Defaults command
- No other 5 GHz Reset Radio Defaults request has been accepted (only one active request allowed)

Resetting the radio to factory defaults (5 GHz radio card)

To reset the 5 GHz radio card to factory defaults, open the Network Status screen. To access this screen, from the Main Menu press **SETUP > MORE > MORE > SERVICE > YES > MORE > MORE > RADIO**.



Note: The above button numbers and network variables are for reference only.

Once at the Network Status screen, press the unlabeled menu keys in the exact following sequence: **4 > 1 > 3** (see the above graphic). The sequence must be completed within 5 seconds of pressing the first button.

Once the sequence is entered correctly, the Reset Radio menu will be displayed. Press **YES** to reset the radio to its factory default settings. Press **NO** to exit the menu.

Note If the Reset Radio menu is accessed immediately after the monitor is powered on, the YES button will be blank and will not function until the 5 GHz radio card has been initialized.

4 Calibration

Introduction

This section provides procedures to perform all adjustments required to calibrate the Propaq CS monitor to conform to Welch Allyn specifications. Calibration requires opening the monitor case. This must be performed only by qualified personnel.

- Calibration includes adjustment of:
- Battery charger
- Main power supply
- Real-time ECG output
- IBP gain
- NIBP gain
- Mainstream CO_2 barometer

Additional circuit testing is also included in this section. Perform calibration to adjust the above parameters if you replace a circuit board or if a parameter does not meet specifications. After any calibration procedure, always perform the Functional Verification procedure ("Functional verification" on page 13).

WARNING Whenever the monitor is opened for calibration or repair, a risk (leakage) current safety check as well as a dielectric strength integrity (hi-pot) test must be performed as described in this section.

Note Respiration, temperature, printer, and SpO_2 options do not require calibration. Sidestream CO_2 has no user-performable calibration. After replacement of any modules to support service of these options, perform a functional verification for those associated modules.

The mainstream CO_2 circuitry should be calibrated only if it fails the functional verification AND you have eliminated all possible faults as listed in the table "Possible sources of CO2 verification test errors" on page 35.

Equipment needed

You will need the following equipment to calibrate the Propaq CS monitor. Part numbers are given for equipment available from Welch Allyn.

Note All test equipment must be calibrated to function within parameters specified by the manufacturer, and be traceable to a national calibration standard.

Table 11. Required equipment

Description
Digital multimeter (DMM), 4 1/2 digit, Fluke 805A or equivalent
50MHz triggered sweep oscilloscope, Tektronix 2225 or equivalent
Variable dc power supply, 0-28 V, 3 A, VIZ WP-715A or equivalent
Patient simulator, Dynatech/Nevada 213A, 214A, 215A, or 217A with temperature and EGG cable/leads
0 to 300mmHg digital manometer with bulb (Netech, Digamano, or equivalent)
Invasive blood pressure (IBP) simulator, 5μ/V/mmHg, Fogg Systems BP48C, BP28, or MDE Datasim 6000, with IBP cables
Adult cuff (provided with monitor); cylindrical object about the size of an adult's arm
Welch Allyn cuff calibration kit, Welch Allyn part number 008-0012-XX
Propaq CS ac power adapter (provided with monitor)
Resistor test loads (4.9Ω and 4.65Ω). Refer to "Manufacturable test equipment" on page 135.
DC supply cable, Welch Allyn part number 008-0290-XX
Tools necessary to disassemble and reassemble the monitor. (See "Required tools" on page 60 for a list of necessary tools and instructions on opening the monitor.)

Setup

Caution All calibration, service, and repair must be done at a static-protected work station. Failure to protect against damage due to static discharge can damage components in the Propaq CS monitor.

To calibrate the monitor you must open and then perform some disassembly to reach the necessary calibration points.

Caution Refer to "Repair procedures" on page 59 for all disassembly and reassembly procedures. Failure to follow disassembly procedures may result in damaged internal parts.

1. Before you begin disassembly, charge the battery pack for at least 8 hours to ensure it is fully charged.
2. Remove any options attached to the monitor. If either the SpO_2 or expansion module is attached to the monitor, remove it before starting the calibration. The calibration procedures in this section are for the three monitor boards only.
3. Remove the battery pack.
4. Disconnect the ac power adapter from the monitor's right side panel power input connector.

5. Open the monitor.
6. Disconnect P1 (expansion connector cable) from the Analog Board and open the front chassis approximately 90 degrees.

Note To disable the alarms while performing the calibration procedures:

press **SETUP > ALL ALARMS > YES** to remove the bell symbol from the display

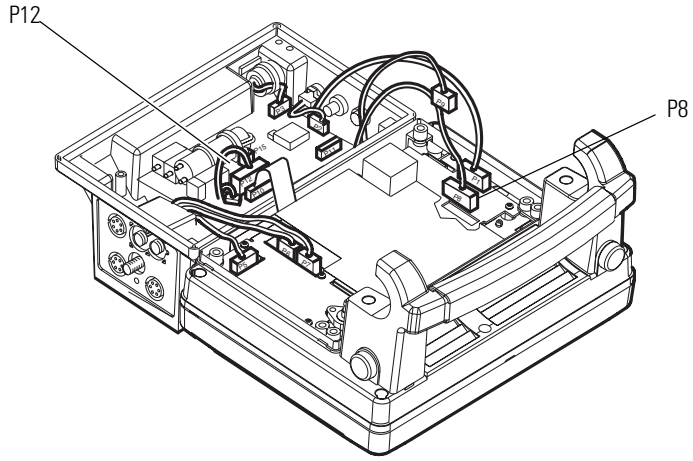
To inhibit the Apnea alarm, turn off Respiration monitoring:

press **ECG/RESP > MORE** and set RESP to **OFF**

Recharger supply adjustments

1. Verify that the monitor power switch is off.
2. Disconnect the battery connector from P12 on the Recharger Board (see below).
3. Disconnect P8 from the Digital Board (see below).

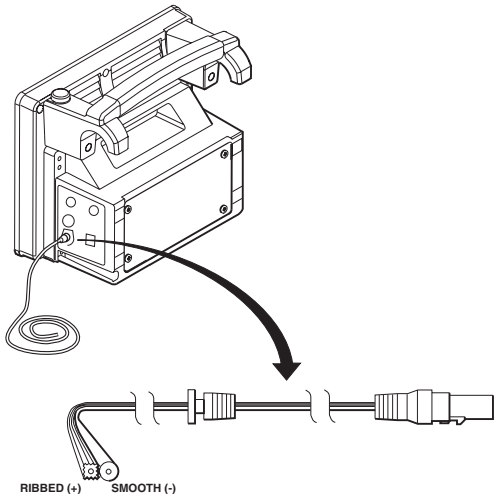
Figure 1. Disassembled front chassis and disconnection locations



4. Connect the 4.9Ω test load (see "Manufacturable test equipment" on page 135) to the battery connector (P12).
5. Set the power supply output to 15.0 V dc.

Caution Adjustment of RP3 in step 12 on page 47 sets an overvoltage limit which, if misadjusted, can cause fuse F1 (on the right side panel) to open. If you suspect that RP3 has been misadjusted, turn it fully clockwise before connecting power to the dc input jack on the Propaq CS monitor.

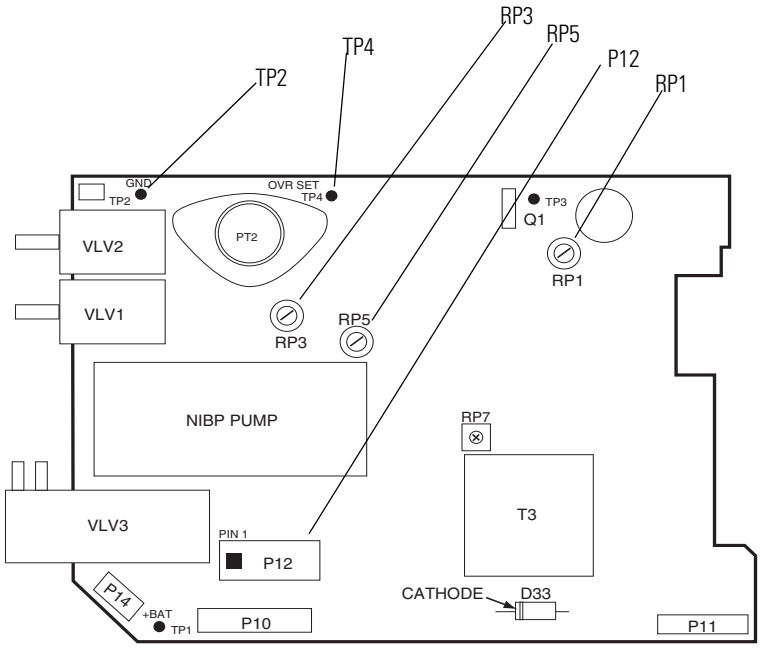
6. Attach the dc power adapter cable to the variable dc power supply as shown in the figure below.



7. Connect the adapter cable to the monitor's dc input jack.

8. Verify that the input current from the variable dc power supply is less than 1.8 A and that the green LED on the monitor's right side panel is on.

Figure 2. Recharger PCB measurement and adjustment locations



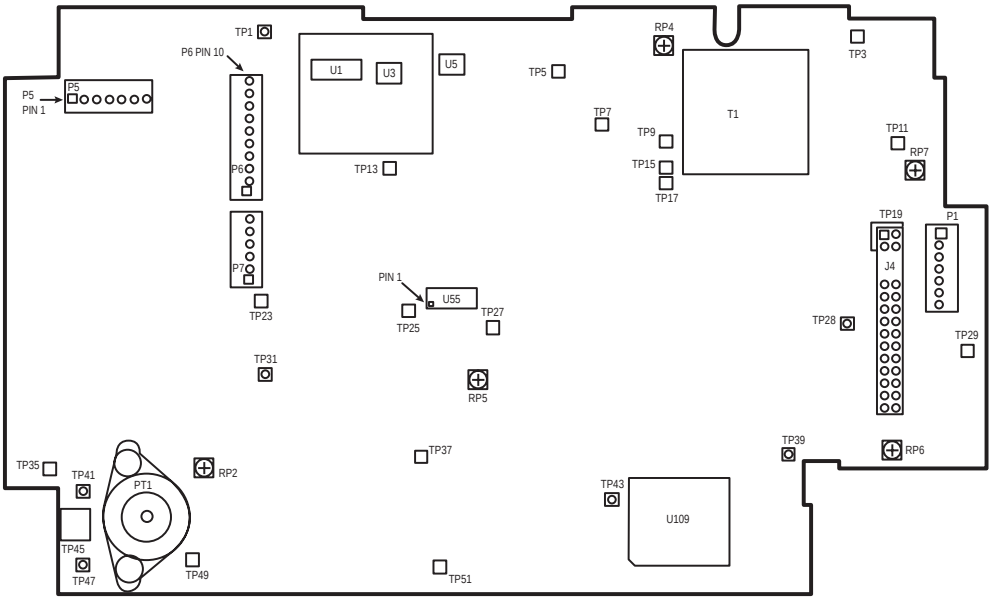
9. Connect the DMM positive lead to P12 pin 1 or 5.
10. Connect the DMM reference (negative) lead to non-isolated ground at TP2.
11. Adjust RP5 to 9.400 ± 0.010 V dc.
12. Move the DMM positive lead to TP4.
13. Adjust RP3 to 2.393 ± 0.015V dc.
14. Move the positive lead back to P12 pin 1 or 5.
15. Vary the input voltage from 12 to 28 V and check that the output voltage remains constant. The battery load voltage must not vary more than 0.100 V dc.
16. Decrease the power supply voltage from 12 to 7 V while checking the right side panel green LED. The LED should turn off between 7 and 12 V.
17. Disconnect the adapter cable from the monitor's right side panel.
18. Remove the 4.9Ω test load and replace it with the 4.65Ω test load.
19. Reconnect the adapter cable.
20. Adjust RP1 to 9.350 ± 0.010 V dc.
21. Remove the 4.65Ω.
22. Reconnect the cable to P12.

Main power supply adjustments

The following procedures assume you are continuing from the Recharger Board calibration. If not, refer to the setup procedures provided at the beginning of this section.

1. Turn off the monitor.
2. Remove the metal shield from the Analog Board. (Note the two different screw sizes; refer to "Repair procedures" on page 59 for instructions, if necessary.

Figure 3. Analog PCB measurement and adjustment locations



3. Connect the DMM reference lead to TP39.
4. Connect the DMM positive lead to TP29.
5. Turn on the monitor.

   Press any of the lower five buttons to reset the monitor following equipment alerts.
6. Adjust RP7 to 5.000 ±0.010 V dc.
7. Refer to the table below and check the dc supply voltages using the DMM.

Table 12. Main power supply voltage checks

Supply voltages	Ref. lead	Pos. lead	Voltage limits (V)
Non-isolated			
+15	TP39	TP3	+14.7 to +15.3
–15	TP39	TP11	–14.8 to -15.5
Isolated			
+VR	TP43 or TP1	TP9	+4.91 to +5.09
+VS	TP43 or TP1	TP5	+6.58 to +7.15
–VS	TP43 or TP1	TP21	-6.65 to -7.15
+VB	TP43 or TP1	TP13	+5.40 to +6.10
+5.6	TP43 or TP1	TP33	+5.55 to +5.70
IBP shield	TP43 or TP1	P6, Pin 10	+2.47 to +2.53
C.L.P. detector [a]	TP43 or TP1	U5, Pin 1	0.00 to +0.25
NIBP Pressure Offset	TP43 or TP1	TP31	+2.40 to +2.60
OSC baseline	TP43 or TP1	TP47	-0.95 to -1.25
+VA	TP43 or TP1	TP7	(+VR + 0.1 V) to (+VR + 0.2 V)
-VA	TP43 or TP1	TP15	(+VR + 0.2 V) to -(VR + 0.35 V)
+2.5	TP43 or TP1	TP17	+2.48 to +2.52

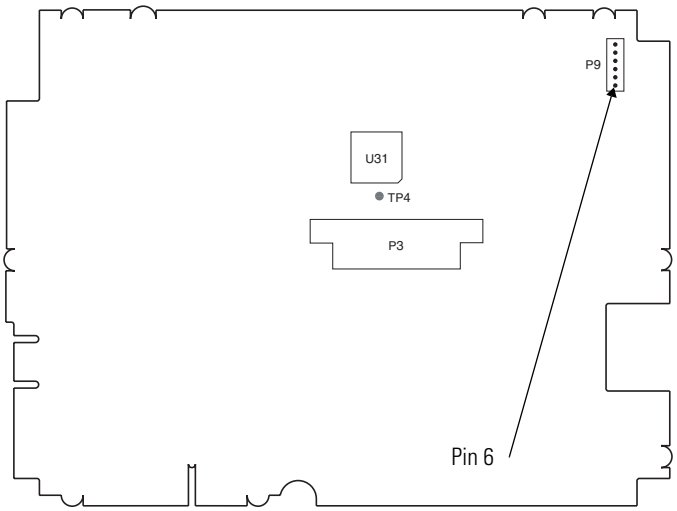
a. Make sure the ECG input connector (P5) is disconnected from the Analog Board for this measurement. Reconnect when done.

8. Disconnect the DMM leads.

Calibrating realtime ECG out

1. Connect the 5-lead ECG cable to the monitor and the simulator.
2. Set the simulator to 80 bpm, normal sinus rhythm.
3. Set the monitor to Lead II.
4. Connect the dc-coupled oscilloscope probe to P9 pin 6 on the Digital PCB, and the reference probe to TP4 on the Digital PCB.
5. On the Analog Board, carefully short together U55 pins 1 and 2.
6. Adjust RP6 on the Analog PCB to 0.0 ± 0.1 V dc.
7. Remove the short and check for an ECG signal displayed on the oscilloscope of 1.0 ± 0.1 V baseline to peak of the R-wave.
8. Disconnect the ECG cable from the monitor.

Figure 4. Digital PCB measurement and adjustment locations

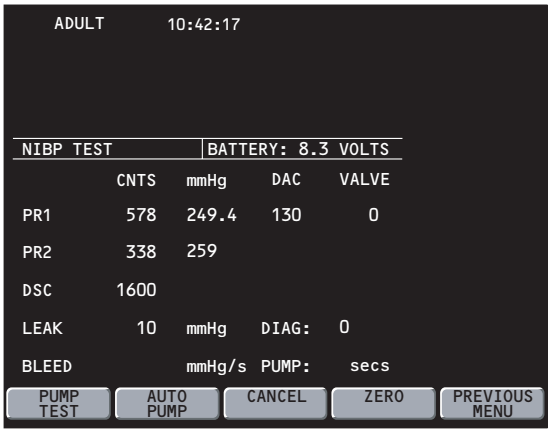


Noninvasive Blood Pressure calibration

1. Connect the cuff, digital pressure meter, bulb, and the Encore together with the cuff calibration kit. Using T-connectors from the kit, connect the cuff, pressure meter, and bulb.
2. Connect this NIBP test setup to the pressure transducer at PT1 on the Analog board.
3. Wrap the adult cuff around the black tube volume or a cylindrical object about the size of an adult's arm.
4. Press **SETUP > MORE > MORE > SERVICE > YES > NIBP TEST > NIBP CAL**. Use the bulb to inflate the system pressure to 250 mmHg, as read on the pressure meter.

Note If testing takes more than 10 minutes, NIBP CAL will cancel. Press NIBP CAL again and resume testing.

5. Watching the value of PR1 on the monitor screen, adjust RP2 until the service screen reading matches the pressure meter.



6. Manually change the system pressure to check linearity tolerances at the following levels:

Pressure (mmHg)	Tolerance (mmHg)
270	±4
250	±3
200	±2
100	±2
50	±2
20	±2

7. Deflate the pressure to 0 mmHg.
8. Disconnect the tube from the transducer.
9. Set the oscilloscope to ac-coupled, bandwidth limited.
10. Connect the oscilloscope probe to TP47 on the Analog Board.

11. Connect the oscilloscope reference lead to TP43 or TP1 on the Analog Board.
12. Check for ≤15 mV peak-to-peak noise.

Note Measure the low frequency noise (bounce) only. Make the peak-to-peak measurement from the center-to-center of the trace to disregard the "fuzzy" high frequency noise.

13. Disconnect all patient inputs to the monitor's left side panel.

Invasive Blood Pressure

Skip this part of the calibration procedure if your monitor does not support IBP measurements.

Caution Many blood pressure simulators are not intended for use as calibration standards. Use only recommended simulators for calibrating the monitor.

1. Connect the IBP simulator to P1 on the monitor left side panel.
2. Set the patient simulator to 0 mmHg.
3. Press ZERO P1 to zero the channel.
4. Set the patient simulator to 200 mmHg.
5. Adjust RP5 for a numeric reading of 200 mmHg on the monitor screen.

Note If your Propaq CS monitor does not include a second pressure channel, skip Steps 6 - 10.

6. Move the IBP cable to the P2 connector.
7. Set the simulator to 0 mmHg.
8. Press ZERO P2 to zero the channel.
9. Set the simulator to 200 mmHg.
10. Check that P2 displays 200 ±2 mmHg.
11. Disconnect all patient cables from the left side panel.
12. Reinstall the Analog Board shield and torque it according to the procedure in "Replacing the Analog Board" on page 73.

MSP Board (MCO_2) calibration

The monitor MSP Board has two calibration adjustments. One adjustment (RP2) is a null adjust for electromagnetic interference emissions—this adjustment has no effect on MCO_2 performance/accuracy. The other adjustment (RP1) is a barometric pressure/ altimeter setting. This adjustment is set at Welch Allyn during the production calibration process and does not require readjustment for use at other altitudes.

Note "Mainstream CO2 verification procedure" on page 34 verifies MCO_2 accuracy. if the verification test results are within specifications, board calibration is not required. If verification test results exceed specification limits, RP1 calibration MAY or MAY NOT be required. Before adjusting RP1, check test parameters as indicated in the table "Possible sources of CO2 verification test errors" on page 35 to minimize testing errors. Determine local barometric pressure as described in the table "Local uncorrected barometric pressure (LUP) as a function of altitude (feet)" on page 31 to verify monitor barometer setting. Adjust RP1, if required, as instructed below.

1. From the monitor Main Menu, press **SETUP > MORE > MORE > SERVICE > YES > CO2 TEST > MAIN TEST** and observe the displayed barometric pressure. Verify that the displayed pressure is within 3 mmHg of the local barometric pressure as calculated in "Local barometric pressure" on page 30.
2. Adjust RP1 on MSP Board if required to calibrate displayed pressure to specified limits.
3. Using an oscilloscope with a 1X probe, connect probe tip to TP50 on the MSP Board. Leave probe groundtip open.
4. Adjust RP2 for minimum high frequency (100kHz) signal.

WARNING You must perform a functional verification after calibrating the Propaq CS monitor to ensure all monitoring functions and safety features operate normally.

Note Because the battery was disconnected in the calibration procedures, you will need to reset the time, date and all saved settings. See the *Propaq CS Directions For Use* for information on resetting these parameters.

5 Troubleshooting

Introduction

This section provides information that can be helpful in troubleshooting the monitor.

Screen messages

Messages may appear on the display to inform the operator of some condition requiring operator or service attention. Messages that indicate that the Propaq CS monitor may need servicing are listed below. For information about other messages, refer to the *Propaq CS Directions For Use*.

PROGRAM FAULT: SETTINGS LOST, TIME/DAY RESET. If this message appears when the monitor is first turned on, it generally indicates a drained battery. The monitor can be used, but the time and date and all other settings will return to factory defaults each time the monitor is turned off. Replace the battery as soon as possible and reprogram the time, date, and other settings according to the *Propaq CS Directions For Use*.

CUFF FAULT: NIBP DISABLED, SERVICE REQUIRED. A single fault was encountered in the NIBP system. Perform a functional check and calibration or repair as needed.

CALIBRATION ERROR, TEMP DISABLED. This message appears when the monitor has detected that temperature circuitry is out of calibration. The temperature channel is disabled until the monitor is repaired. There are no temperature channel adjustments; the temperature channel uses a regulated power supply as a reference. Check all power supply values ("Main power supply adjustments" on page 48). The Analog board may need to be replaced.

SENSOR FAILURE - EEPROM - (MCO_2). A failure in the sensor EEPROM is detected (typically a checksum error). The CO_2 channel is disabled until the sensor cable is disconnected. Replace the sensor.

SENSOR FAILURE, HEATER - (MCO_2). A failure in the sensor temperature control hardware is detected. This is typically a sensor error, but may be an MSP board fault. Replace the sensor or MSP board as required.

SENSOR FAILURE, MOTOR DRIVE - (MCO_2). The mainstream sensor motor drive hardware has failed. The channel is disabled until the sensor is disconnected. Replace the sensor.

DEGRADED WAVEFORM, CHECK ADAPTER - (MCO_2). The airway adapter (cuvette) may be contaminated or the light source in the sensor may be faulty. Clean or replace the cuvette as required or replace the CO_2 sensor.

LACK OF WAVE, CHECK ADAPTER, SENSOR - (MCO_2). The airway adapter (cuvette) may be contaminated or the light source in the sensor may be faulty. Clean or replace the cuvette as required or replace the CO_2 sensor.

SENSOR FAILURE, CALIBRATION ERROR - (MCO_2). A Sensor failure has occurred. Replace the sensor.

PUMP FAILURE, SERVICE REQUIRED - (SCO_2). The sidestream pneumatic tubing is kinked or a pump failure on the SSP board has occurred. Correct the tubing problem or replace the SSP board as required.

DEGRADED WAVEFORM-SERVICE REQUIRED - (SCO_2). This error indicates possible contamination or light source failure in the CO_2 measurement chamber (bench) that is located on the Stick board or by a failure of the SSP Board. Replace the Stick or SSP board as required.

LACK OF WAVEFORM-SERVICE REQUIRED - (SCO_2). This error indicates possible contamination or light source failure in the CO_2 measurement chamber (bench) that is located on the Stick board or by a failure of the SSP Board. Replace the Stick or SSP board as required.

MOTOR FAILURE-SERVICE REQUIRED - (SCO_2). The motor drive in the CO_2 bench has failed. Replace the Stick board.

CALIBRATION ERROR-SERVICE REQUIRED - (SCO_2). A CO_2 bench failure has occurred. Replace the Stick board.

OCCLUSION-CHECK EXHAUST PORT/TUBING - (SCO_2). Repeated error messages after removing any occlusion on the exhaust connector can indicate a defective pump located on the SSP board. Replace the SSP board.

Non-recoverable error codes

Non-recoverable errors are detected by software and indicate the Propaq CS monitor is no longer able to function properly and must be returned to Welch Allyn for service. Contact Welch Allyn Technical Support.

When a non-recoverable error is found, the software attempts to put the error message and its number on the monitor display. All monitoring functions are locked out. Non-recoverable errors are therefore distinct from equipment alerts, which permit reduced monitoring capability.

Non-recoverable errors are indicated in the following format x - yyy -zzzz

where:

- x = 0 indicates a problem found by the Display Control Processor (DCP).
- x = 1 indicates a problem found by the Data Acquisition Processor (DAP).
- x = 2 indicates a problem found by the Printer Control Processor (PCP) on the Printer Main board.
- x = 3 indicates a problem found by the SpO_2 Control Processor (SCP) on the SCP board.
- x = 5 indicates a problem found by the Main Stream Processor (MSP) on the MSP (CO_2) board.

x = 7	indicates a problem found by the Side Stream Processor (SSP) on the sidestream main board.
yyy-zzzz	indicate specific types of problems. Contact Welch Allyn Technical Support for more details.

Battery capacity check

Several variables affect monitor operating time on battery:

- active options
- frequency of NIBP measurements
- frequency and length of printouts
- ambient temperature,
- battery age and condition
- displayed information.

Refer to the *Propaq CS Directions For Use* for battery care information and expected operating times. If the monitor fails to operate on battery for an extended period of time, follow the procedure below to check the capacity of the monitor's lead acid battery. Lead acid batteries have a very limited shelf life; you must test the battery if the monitor has been stored for two or more months without the ac power adapter plugged in.

Caution A new battery should pass the following test. The run time of older batteries will decrease proportionally with age. Replacement is recommended when the run time becomes insufficient for the monitor's intended application.

1. Use the ac power adapter and charge the monitor for at least 8 hours with the monitor turned off (12 hours if a printer or pulse oximeter is attached).
2. Disconnect the cuff and all cables from the monitor.
3. Turn off all printing (if a printer is attached).
4. Disconnect the power adapter.
5. Turn on the monitor.
6. Run the monitor for the typical operating time as shown in the table. Confirm that the monitor does not shut off before the specified time.

Monitor configuration	Typical operating time with a new battery
Stand-alone monitor	2 hours
Monitor with SpO_2 option (no Expansion Module)	4 hours
Monitor with Expansion Module with printer, SpO_2, and CO_2 options	3 hours

7. Turn off the monitor.
8. Use the ac power adapter and charge the monitor for at least 8 hours with the monitor turned off. (Charge at least 12 hours if a printer or pulse oximeter is attached.)

6 Repair procedures

Introduction

This section provides instructions for removing and replacing serviceable modules in the:

- Propaq CS monitor
- Expansion Module (which may include any or all of the following: printer, SpO_2, Mainstream CO_2 , Sidestream CO_2)
- SpO_2-only module

This section also describes how to replace the input fuse and battery pack.

Note In general, re-assembly procedures are the opposite of the disassembly procedures. If there are items to note during re-assembly, they are described after the disassembly section.

WARNING Whenever the monitor is opened for calibration or repair, a risk (leakage) current safety check and a hi-pot test must be performed followed by a complete functional verification. These procedures are located in "Functional verification" on page 13.

Propaq CS Monitor software

Propaq CS monitor system software is contained in PROMs (programmable read-only memory) on various system boards. The following PROMs may require replacement during board exchange processes. Refer to "Replacing PROMs" on page 80 for replacement instructions.

- DAP PROM on the Analog Board in the monitor
- PCP PROM on the Printer Main Board in the Expansion Module
- SCP PROM on the SCP Board in the SpO_2 option
- MSP PROM on the Mainstream CO_2 Board (MSP) in the Expansion Module
- SSP PROM on the Sidestream Main Board (SSP) in the Expansion Module

When you remove one of these boards for replacement, you should remove the PROM from the board and store it in an anti-static plastic bag until you receive the replacement board. Keeping the PROM allows you to install it in the new board and ensures the replacement board will be compatible with the rest of your monitor system software.

Note The DCP PROMs and the Digital Board are not field replaceable due to external programming requirements. Do not remove the DCP PROMs. For Digital Board service and/or a DCP software update, contact your Welch Allyn Service representative.

Caution POSSIBLE DAMAGE FROM STATIC DISCHARGE

All calibration, service, and repair must be done at a static-protected work station. Failure to protect against damage due to static discharge may reduce monitor operation life and increase repairs. Place the monitor in an anti-static area before servicing the monitor.

Required tools

The following tools are required to disassemble and reassemble the Propaq CS monitor components.

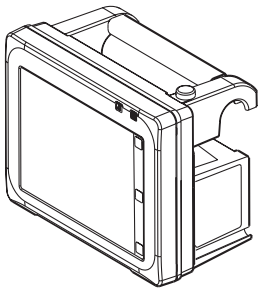
Table 13. Required tools

Description
Phillips screwdrivers, #1 and #2
Flat blade screwdriver
Adjustable torque screwdriver (2.5in-lb to 7.35in-lb.; .43N-m to .83N-m), with Phillips and 3/16" nut driver heads
Tweezers to help with screw removal and replacement
Static-free mat and wrist band equipment
Wire cutter to remove tie wraps
Tie wrap tool
De-ionized (neutralized), filtered, dry, non-combustible gas under pressure for removing any dust or debris from the monitor's interior.
Pliers, standard needle-nosed
Pliers, looping - non-serrated, rounded edges for use on tubing
PROM Remove Tool: Amp Part Number 821903-1

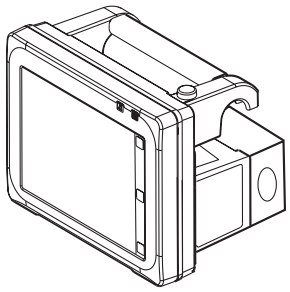
Caution It is recommended you use deionized gas for removing dust and debris prior to reassembly of monitor components. Commercial devices are available to neutralize compressed gases.

Propaq CS Monitor options

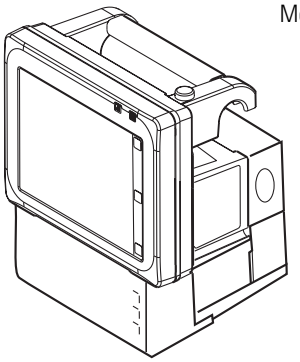
Your monitor may contain an option module that attaches to the monitor. You must remove the option module before you can disassemble the monitor. For instructions on how to remove the Expansion Module, refer to "Replacing the battery pack" on page 64. For instructions on how to remove the SpO_2 module, refer to "Removing the dual battery in expansion module" on page 66.



Monitor



Monitor with SpO_2



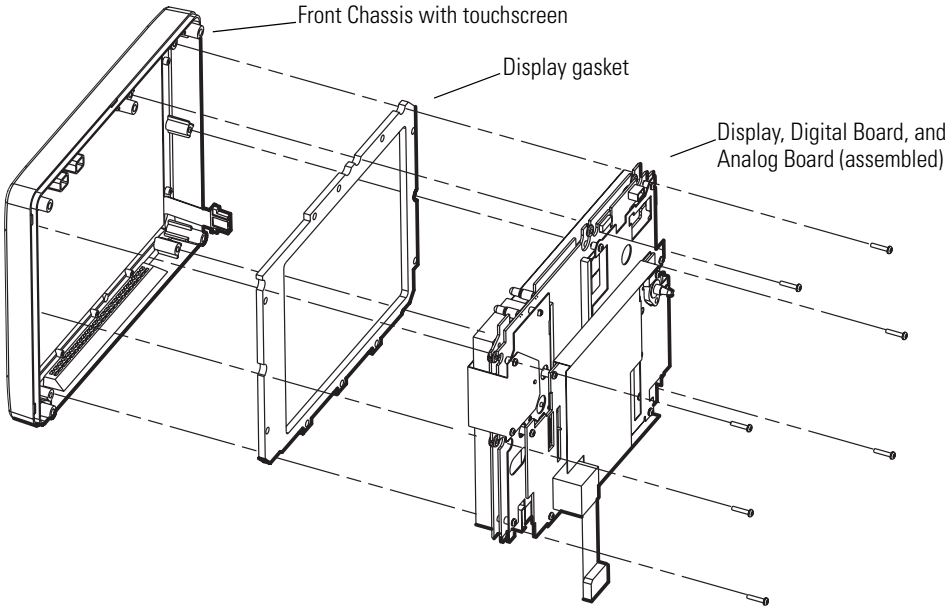
Monitor with
Expansion Module

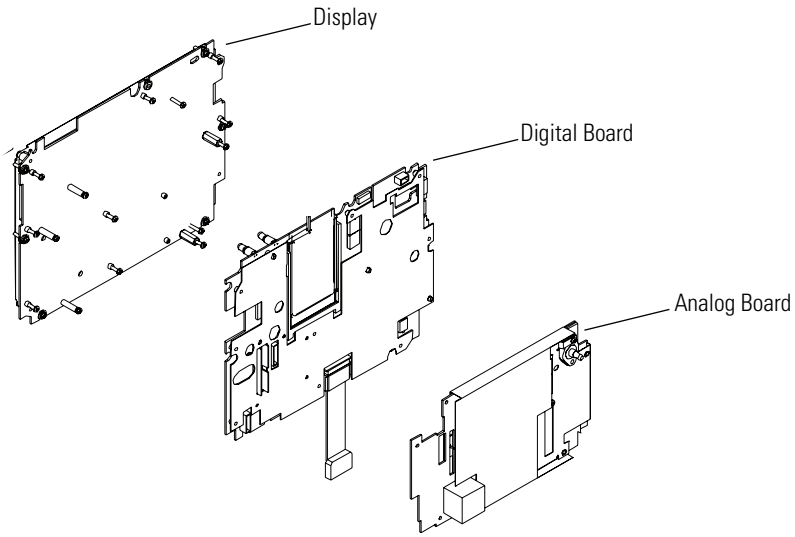
Field-Replaceable Units in the monitor

Front chassis

The Front Chassis of the monitor contains the following components:

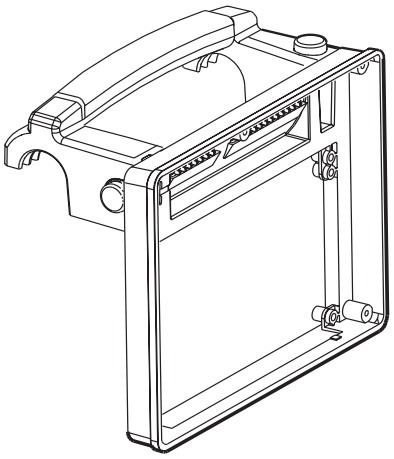
- Insulator
- Analog Board with metal shield and insulator
- Digital Board with shields
- LCD display module
- Front Chassis plastic assembly with touchscreen, gasket, and elastomeric LED lens



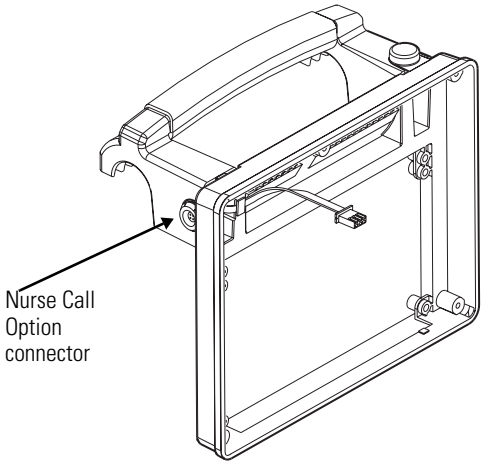


Interface chassis

The Interface Chassis is available either with or without the Nurse Call option.



Standard Interface Chassis

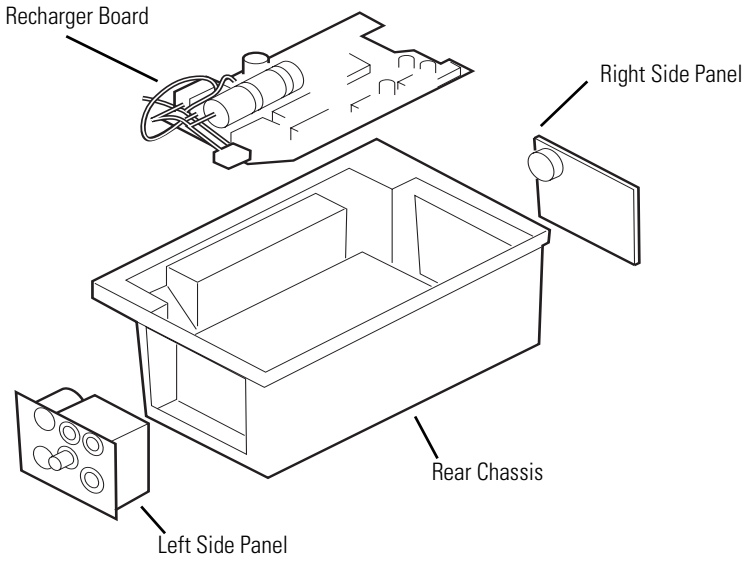


Interface Chassis with Nurse Call Option

Rear chassis

The Rear Chassis contains the following components:

- Recharger Board
- Side panels (right and left)
- NIBP pump
- NIBP tubing
- NIBP valves

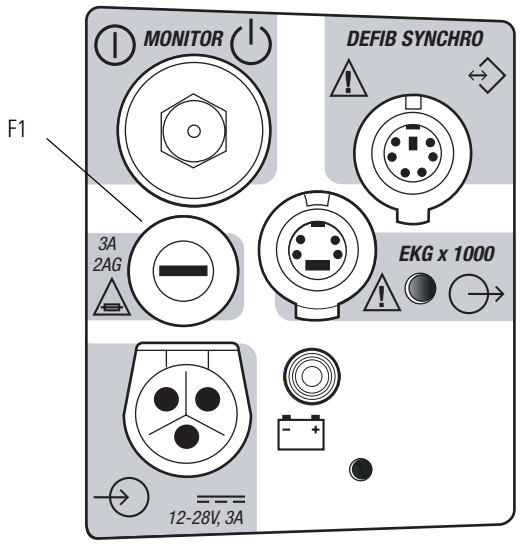


Replacing the power input fuse

The Fuse F1 protects the Recharger Board circuitry against excessive current at the dc input connector. You do not need to disassemble the Propaq CS monitor to replace this fuse.

Check fuse F1 if the ac power adapter is functioning properly and the following two conditions exist:

- the green LED charging indicator on the monitor's right side panel does not illuminate
- the monitor battery does not charge



To remove the fuse, use a flat blade screwdriver to turn the fuse cover and release the fuse.

Caution Replace the fuse only with one of the same rating and size. See "Field Replaceable Units (FRUs)" on page 129 for Welch Allyn part numbers.

Replacing the battery pack

WARNING Although the battery pack includes a fuse to prevent against personal and equipment damage, the sealed lead-acid battery pack is capable of quickly delivering dangerously high currents if improperly handled, misused, or abused. These current levels may burn skin or damage the Propaq CS monitor. Use extreme caution when handling the battery pack.

Note The battery fuse is not replaceable. If the battery is shorted, the entire pack must be replaced. Do not try to service the battery fuses.

Insert a new battery pack into the Propaq CS monitor when the current battery no longer holds an adequate charge. Verify that the battery charges to capacity ("Battery capacity check" on page 57).

Keep the battery away from children. Do not disassemble it and do not incinerate or burn it.

The battery maintains programmed defaults and time of day. Without the battery, the values for these items return to the factory settings. If the power up error message TIME/DATE SETTINGS LOST is displayed, reprogram the time and day and monitoring default parameters according to the procedures described in the *Propaq CS Directions For Use*.

WARNING Do not pinch the battery wires when inserting the battery pack into the Propaq CS monitor. Monitor failure or fire could occur if wires get pinched.

You must remove the battery pack before opening the monitor case and replacing components. A Propaq CS monitor without options contains a single battery pack. A monitor with an option package uses a dual battery package.

Within the European Union

Do not dispose of this product as 'unsorted municipal waste'. Prepare it for reuse or separate collection as specified by Directive 2002/96/EC of the European Parliament and the Council of the European Union on Waste Electronic and Electrical Equipment (WEEE).

Note If the monitor or the battery is contaminated, this directive does not apply.

For more specific disposal information, see www.welchallyn.com/weee, or contact Welch Allyn Customer Service.

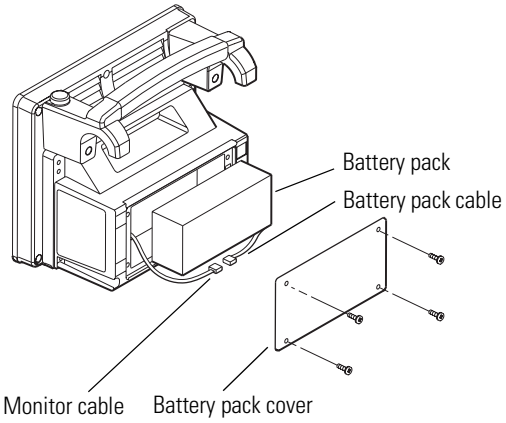
Outside the European Union

When the monitor or the battery reaches end of life, recycle it locally according to national, state, and local regulations, or return it to Welch Allyn.

Removing the single battery pack

The following steps describe how to remove the battery pack from the monitor:

1. Using a flat blade screwdriver, unscrew the four screws securing the battery pack cover as shown below.



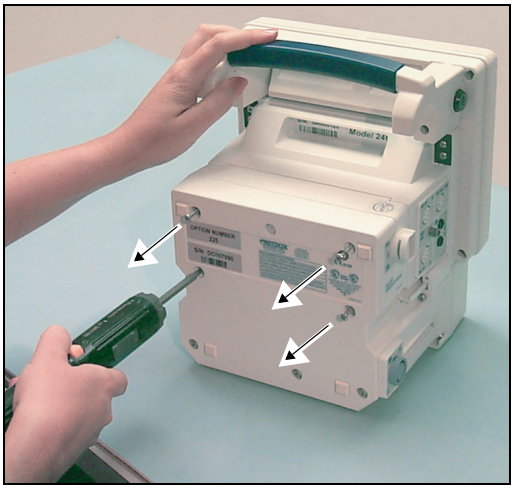
2. Disconnect the monitor cable from the battery pack cable.
3. Remove the battery pack from the monitor.
4. Store the battery in a safe place while disassembling the monitor.

Removing the dual battery in expansion module

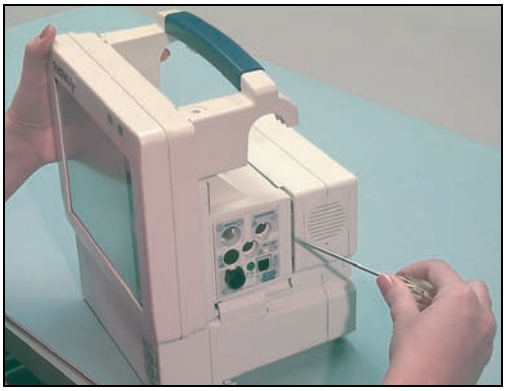
The Expansion Module uses a dual battery pack. The following instructions describe how to remove the dual battery.

Note Four screws secure the Expansion Module to the monitor. Four additional screws secure the rear panel to the Expansion Module Chassis; do not remove these additional screws.

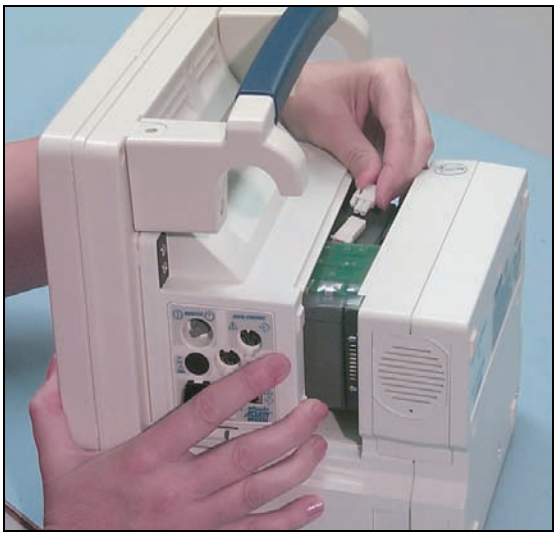
1. Using a Phillips screwdriver, remove the four screws securing the Expansion Module to the monitor (see below).



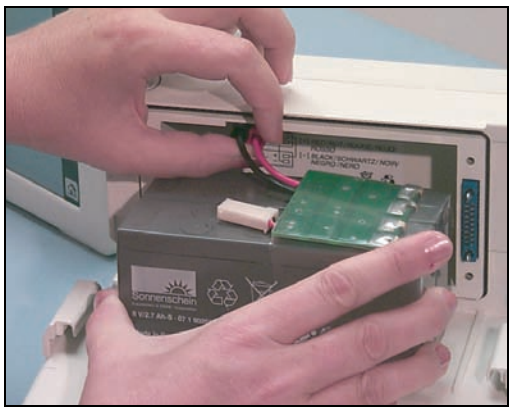
2. If necessary, use the flat blade screwdriver to gently loosen the Expansion Module from the monitor (see below).



3. Slide the monitor forward until you can disconnect the battery pack cable from the monitor's power cable (see below). The battery pack should remain in the Expansion Module Chassis.



4. Continue to slide the monitor forward until it can be completely separated from the Expansion Module.
5. Slide the dual battery pack forward out of the Expansion Module until the battery connector can be reached.
6. Disconnect the battery connector from the Expansion Module (see below).



7. Remove the dual battery pack from the Expansion Module.
8. Store the battery in a safe place while disassembling the monitor and Expansion Module.

When reconnecting the Expansion Module, confirm that the continuous O-ring gasket is correctly in place.

Removing the dual battery in SpO_2 module

The steps for removing the battery pack from the SpO_2 module are similar to the steps required to remove the battery from the Expansion Module. The monitor is secured to the SpO_2 module with four screws with washers.

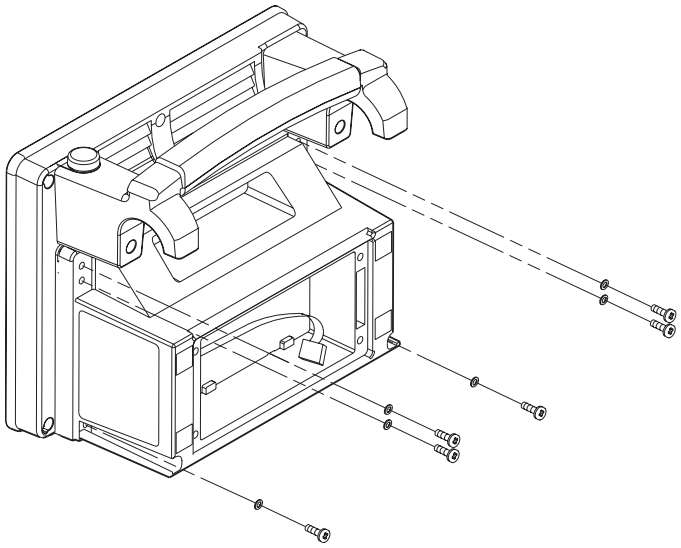
1. Using a Phillips screwdriver, remove the four screws from the SpO_2 module rear panel.
2. Slide the monitor forward until you can disconnect the battery pack cable from the monitor's power cable.
3. Slide the monitor forward until it can be completely separated from the SpO_2 module.
4. Remove the dual battery pack.
5. Store the battery in a safe place while disassembling the monitor and SpO_2 module.

When attaching the SpO_2 module, verify that the continuous O-ring gasket is in place.

Opening the monitor

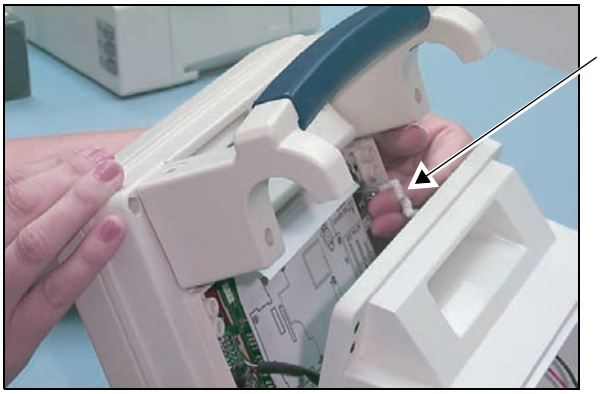
Follow these steps to open the monitor casing and gain access to the three removable monitor boards and display. (You do not need to remove the handle to remove the boards.)

1. Remove the battery pack ("Removing the single battery pack" on page 66).
2. Using a Phillips screwdriver, remove the six screws securing the Rear Chassis to the Interface Chassis.

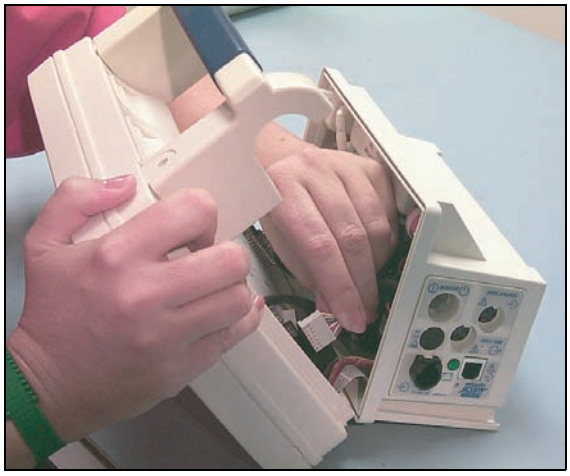


Caution Before opening the casing more than one inch in the next step, disconnect the tube from the pressure transducer at the joint. Failure to disconnect the tubing may cause damage to the transducer or tubing.

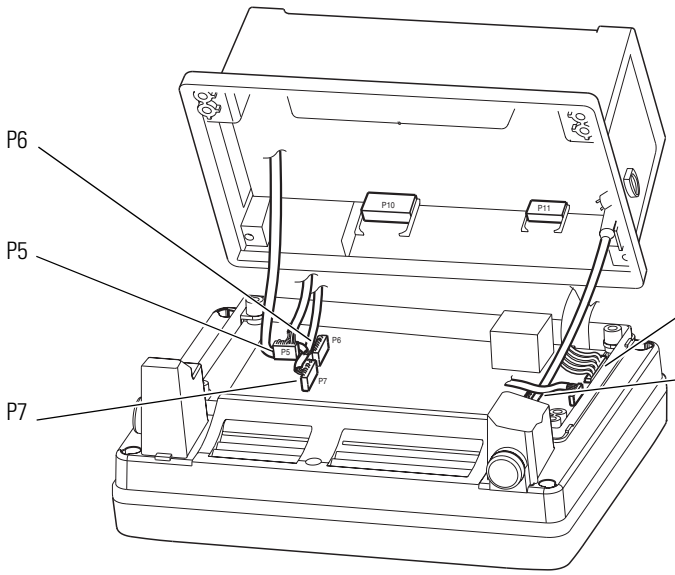
3. Slightly spread the casing open at the top until you can disconnect the pressure transducer tube indicated below.



4. Spread the casing open to an angle of 45 degrees.
5. Detach the expansion connector cable (to P1) from the Front Chassis of the monitor as indicated in the figure below.



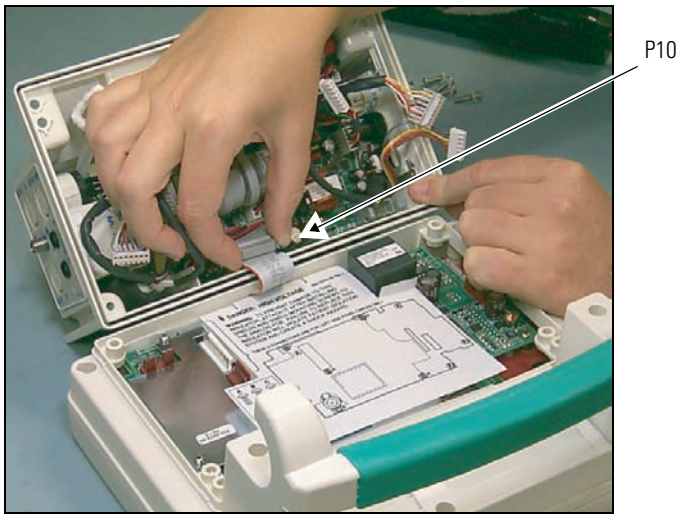
6. Spread the casing open to an angle of about 45-60 degrees.
7. Detach the following cables from the Front Chassis (shown below):
   - Cable to P5 on the Analog Board, from left side panel ECG connector on the Rear Chassis.
   - Cable to P6 on the Analog Board, from left side panel IPB connector on the Rear Chassis.
   - Cable to P7 on the Analog Board, from left side panel temperature jack on the Rear Chassis.
   - Cable to P8 on the lower (Digital) Board, from the right side panel on the Rear Chassis.
   - Cable to P9 on the Digital Board, from the right side panel on the Rear Chassis.



NOTE: You do not need to remove the handle for this procedure. The handle is not shown here so the cable connections are more visible

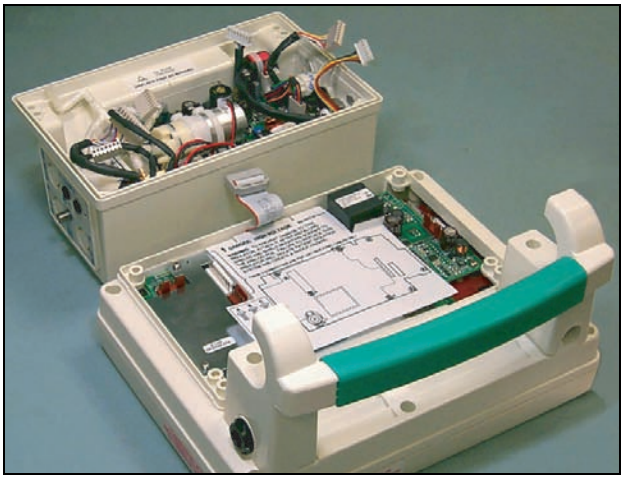
8. Detach the ribbon cable from the Rear Chassis (see below):

   Ribbon cable to P10 on the Recharger Board, from the Digital Board.



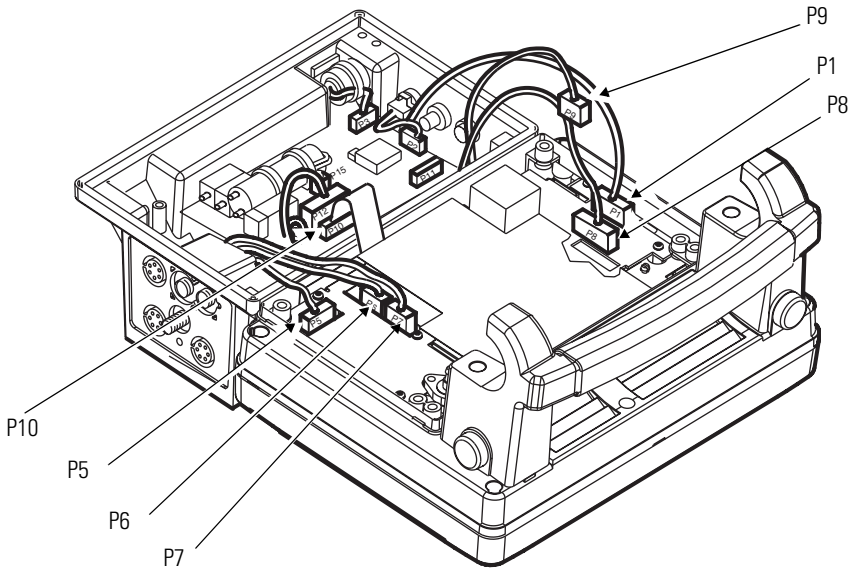
Note The two halves are sealed by rubber gaskets that are recessed around the perimeter of the Rear Chassis. If the gaskets become loose, replace them in the perimeter before reassembling the monitor.

9. Separate the Interface Chassis from the Rear Chassis (see below).



Closing the monitor

1. Before closing the monitor casing, confirm the following:
   - Cable to P6 on the Analog Board goes behind and below the cable to P5, and over the cable to P7.
   - Cable to P5 on the Analog Board goes over and in front of the cable to P6.
   - Cable to P7 on the Analog Board goes under the cable to P6.
   - Cable to P1 (the expansion cable) must not lay over the transformer.
   - Cable to P8 on the Digital Board rests to the right of the transformer and over the ribbon cable and cable to P9.
   - Cable to P9 lies under the cable to P8.
   - All cables and hoses are not pinched.
   - The Front Chassis pressure transducer tube has been securely reconnected.
   - The rubber O-ring gasket is in place in the Rear Chassis.
   - Verify that the P10 locking clips are secure.



2. Torque the five screws securing the Interface Chassis to the Front Chassis to 6.65 to 7.35 in-lb (0.75 to 0.83 N-m).

Caution Route the red and white Display Power Cable down inside the Front Chassis prior to the application of the Interface Chassis to avoid pinching the Cable.

3. Torque the six screws securing the Rear Chassis to the Interface Chassis to 8.0 ± 0.4 in-lb (0.9 ± 0.04 N-m).

Replacing the Analog Board

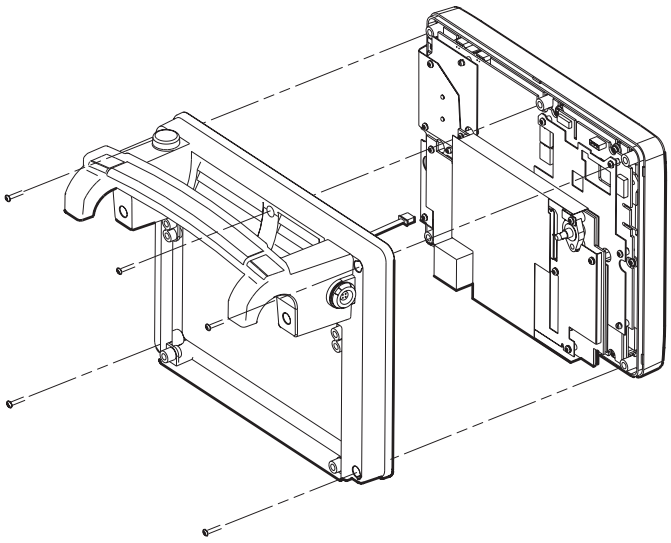
This section provides instructions on removing the Analog Board. The Analog Board is secured in the Front Chassis by five screws: three on the right side of the Board (side containing the transformer), and two passing through the metal shield on the left side of the Board.

Note The Interface Chassis and Front Chassis are sealed by rubber gaskets that are recessed around the perimeter of the Front Chassis. If the gaskets become loose, replace them in the perimeter before reassembling the monitor.

You do not need to lift the plastic insulator nor remove the metal shield to remove the Analog Board. However, you must lift the insulator to calibrate the Board.

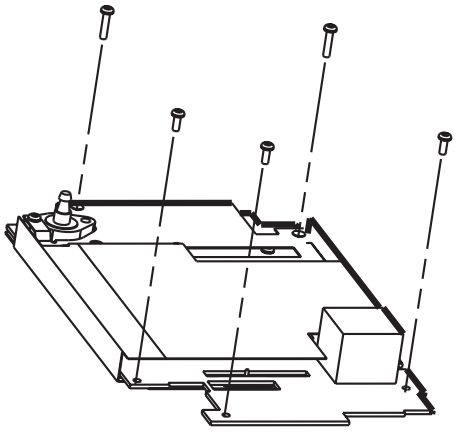
WARNING SHOCK HAZARD - When reassembling, make sure the plastic insulator is correctly installed to maintain patient isolation.

1. Remove the battery pack ("Removing the single battery pack" on page 66).
2. Open the monitor ("Opening the monitor" on page 68).
3. Use a Phillips screwdriver to remove the five screws securing the Interface Chassis to the Front Chassis.
4. Disconnect the Nurse Call Cable (if present) from P1 of the Digital Board.



5. Remove the five screws fastening the Analog Board to the Front Chassis.

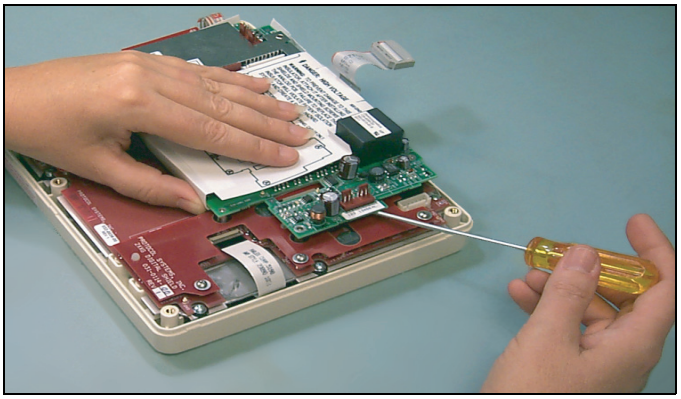
   Note that of the five screws, the two longer screws pass through the metal shield to secure the Board.



Caution The Analog and Digital Boards are connected together on the right side by connectors P4 and J4. It may be necessary to use two flat blade screwdrivers to *gently* pry the boards apart.

Place the screwdriver blades as close to the edge of the board as possible to avoid contacting components on the board. Components are located as close as 1/8" to the edge of the board. Use extreme caution. Try not to flex the board when prying.

6. Gently lift the Analog Board up from the Front Chassis.



When installing the Analog Board:

- Blow out any dust and particulates from the Board using pressurized de-ionized gas before installing it.
- Align the Board so that P4 correctly plugs into J4.
- Torque the three shorter screws holding the Analog Board to 3.8 to 4.2 in-lb (0.43 to 0.47 N-m).
- Torque the two longer screws passing through the shield to secure the Analog Board to 1.0 ± 0.1 in-lb (0.1 ± 0.01 N-m).
- Attach the Interface Chassis to the Front Chassis, connecting the Nurse Call Cable if present.
- Torque the five screws in the Interface Chassis to 8.0 ± 0.4 in-lb (0.9 ± 0.04 N-m).

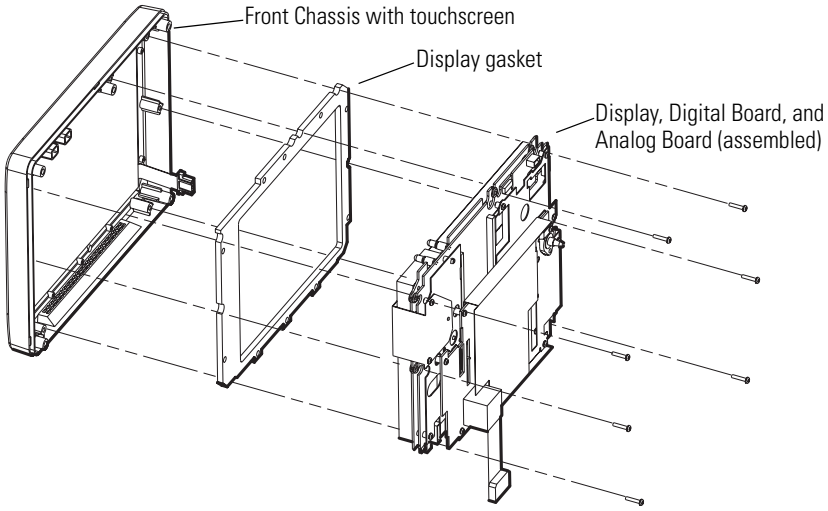
Replacing the Display

Note Do not remove the PROMs from the Digital Board. The Digital Board contains monitor-specific on-board configuration programming that requires special service procedures. For assistance in servicing the Digital Board and software, contact Welch Allyn or your local distributor.

The Digital Board is located beneath the Analog Board. It is necessary first to pull off the board set (consisting of the Display, Digital Board, and Analog Board) in order to disconnect the Display cables from the Digital Board without damaging the cables.

The Display is located beneath the Digital Board. When handling the Display, use gloves or fingercots to minimize cleaning required before reassembly. Handle the Display by grasping the metal interface plate whenever possible.

1. Remove the seven screws securing the Display Module to the Front Chassis. These seven screws are located in the rubber gaskets around the perimeter of the Chassis.

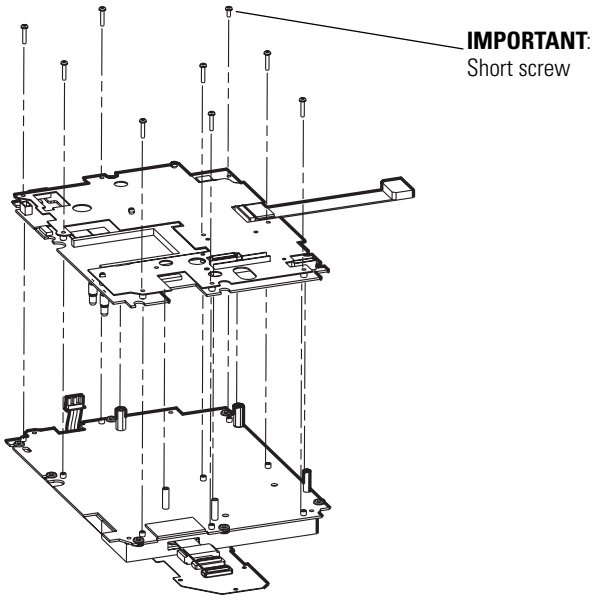


2. Remove the assembled boards (Display, Digital Board, and Analog Board) from the Front Chassis by gently gripping the Analog Board and lifting up.
3. Immediately place the Front Chassis into a clean anti-static protective bag to keep dirt and debris away from the inside of the touchscreen.
4. Remove the Analog Board from the Digital Board ("Replacing the Analog Board" on page 73).
5. Disconnect the following cables:
   - Gently lift the flat cable connector from J7.
   - Disconnect the Display Power Cable from P5.
   - Disconnect the Touchscreen Cable from P6.

Caution The Touchscreen Cable can be easily damaged. To avoid damage, use tweezers to disconnect and connect the Cable. Do not allow sharp bends in the Cable.

6. Remove the snap rivet securing the foil shield over the Display Cable.

7. Remove the nine screws connecting the Digital Board to the Display (see below).



Reinstalling the Display

When installing the Display:

- Make sure the cable between the Digital Board and Recharger Board is installed on the Digital Board first before placing the Digital Board on the Front Chassis.
- Handle all Display cables with care to avoid damage.
- Use ionized air to blow debris out of the Front Chassis before placing the assembled boards (Digital Board, Display, and Analog Board) back into the Front Chassis.

  Clean the inside of the touchscreen using Windex®.

  The viewing surface of the Display is very delicate. Carefully clean the inside of the touchscreen using a lenscloth *lightly-dampened* with *alcohol only* (do *not* use Windex®). Do not allow moisture to remain on the viewing surface.

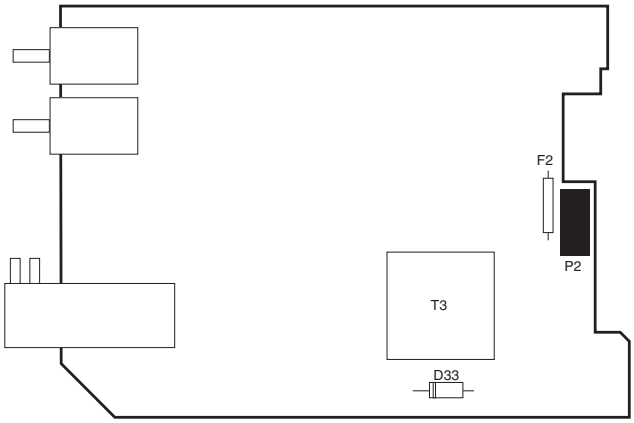
1. Secure the Digital Board to the Display using the nine screws as shown in "Replacing the Display" on page 75. Be sure to use the short screw in the correct location as indicated in the illustration. Torque the screws to 4 ±0.2 in-lb (0.45 ±0.02 N-m).
2. Connect the following cables:
   - Power Cable to P5
   - Touchscreen Cable to P6
   - Display Cable to J7
   - 10-pin Ribbon Cable from the Digital Board to the Recharger Board
3. Secure the foil shield over the Display flat cable using a snap rivet.
4. Secure the Analog Board to the Digital Board using the five screws as shown in "Replacing the Display" on page 75.
   - Torque the three shorter screws to 4 ±0.2 in-lb (0.45 ±0.02 N-m).
   - Torque the two longer screws passing through the shield to secure the Analog Board to 1.0 ± 0.1 in-lb (0.1 ± 0.01 N-m).
5. Gently ease the assembled boards back into the Front Chassis.
6. Secure the assembled boards to the Front Chassis by fastening the seven screws through the rubber grommets. Torque the screws to 1 ±0.10 in-lb (0.11 ±0.01 N-m).
7. Attach the Interface Chassis to the Front Chassis, connecting the Nurse Call Cable if present.
8. Torque the five screws in the Interface Chassis to 8.0 ± 0.4 in-lb (0.9 ± 0.04 N-m).

Replacing Recharger Board fuse (F2)

The Recharger Board fuse (F2) protects the monitor power supply input at the battery line to the monitor. If the monitor does not turn on but the BATTERY CHARGING indicator lights when the ac power adapter is connected, check fuse F2 (3 Amp).

Caution The fuse is heat sensitive and must be soldered with heat sinks in place between the fuse body and the solder joint.

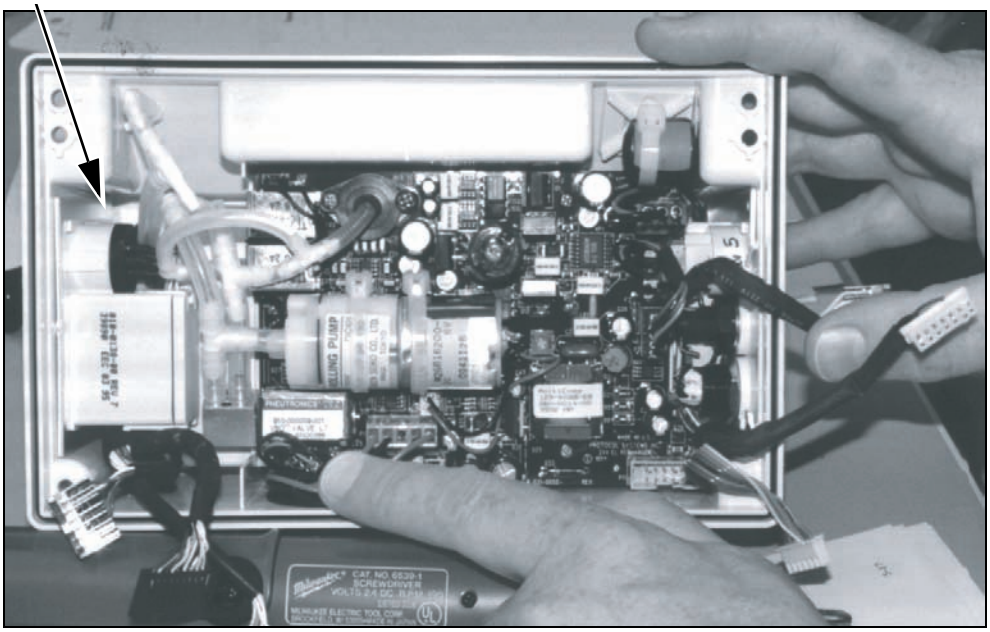
1. Remove the battery pack ("Removing the single battery pack" on page 66).
2. Open the monitor ("Opening the monitor" on page 68).
3. Remove the Recharger Board ("Replacing the Recharger Board" on page 83).
4. Replace the fuse (F2, shown below).



Replacing air tubing

Replace the NIBP tubing as a single assembly to ensure the tubing lengths are accurate. Refer to "Field Replaceable Units (FRUs)" on page 129 for the tubing assembly part number.

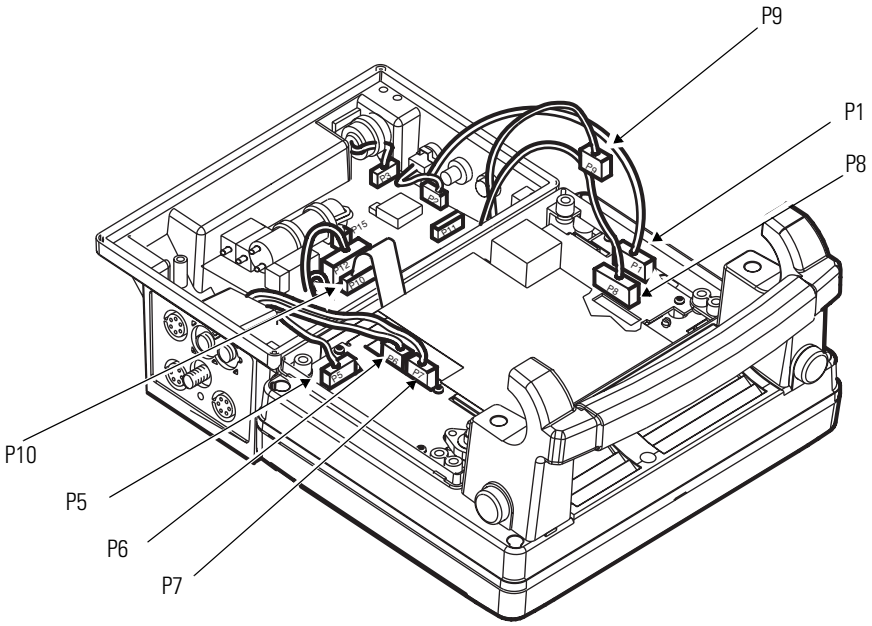
Note If you don't need to replace the length of tubing between the cuff hose connector in the left side panel and the rest of the tubing assembly, don't remove the left side panel to disconnect this tube. Leave that length of tubing connected to the side panel but disconnect it from the rest of tubing assembly as indicated by the arrow in the figure below, and replace the tubing assembly.



Replacing cables

If you suspect a cable is faulty, check its continuity on all pins. If you need to replace a cable, refer to "Field Replaceable Units (FRUs)" on page 129 for part numbers. See below for cable locations.

When removing a cable, be sure to note the routing. Be sure to route the new cable in the same manner.



Replacing PROMs

Please read the information in "Propaq CS Monitor software" on page 59.

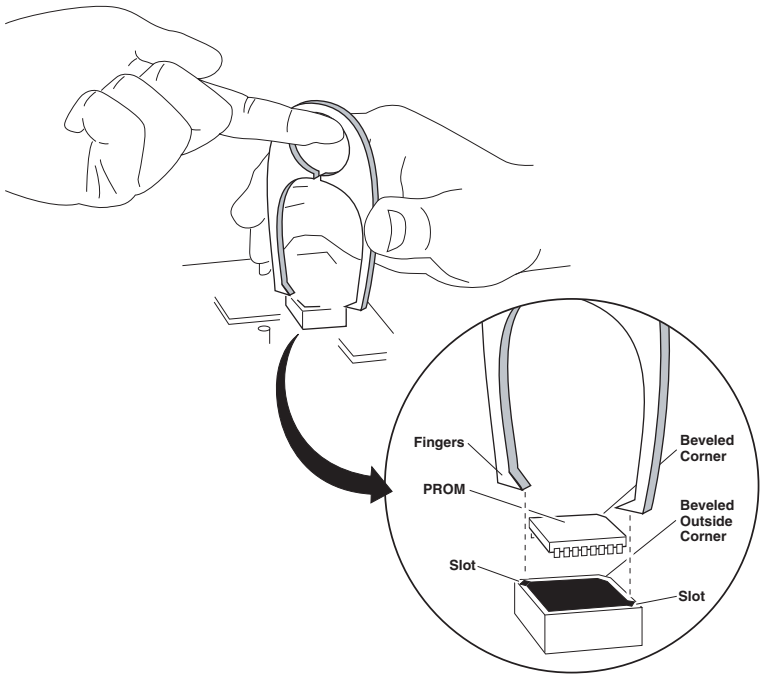
The PROMs require a special removal tool to replace them. See "Required tools" on page 60. To prevent damage to the PROM sockets, do not use any other tools.

Caution The PROMs can be damaged by static discharge. Work only at a static-protected work station.

The following instructions describe how to replace PROMs:

Note Do not remove the PROMs from the Digital Board. For assistance in servicing the Digital Board and software, contact Welch Allyn or your local distributor.

- To remove the PROMs, insert the fingers of the PROM removal tool into the slots at two corners of the PROM and pull out the PROM, while squeezing the legs against the PROM.
- To load the new PROM, align the beveled corner of the PROM with beveled OUTSIDE corner of the socket. Carefully press the new PROM into place.

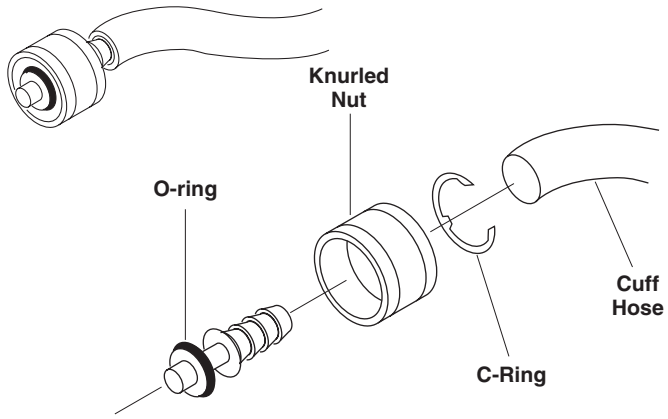

Fingers
Beveled Corner
PROM
Beveled Outside Corner
Slot
Slot

Cuff fittings

Air system integrity in the NIBP system is essential to ensure accurate measurements. Routine wear of the O-ring gasket located in the threaded fitting of the cuff hose can result in air leaks. If you encounter air leaks that can not be found from the tests in this manual, replace the O-ring first.

WARNING Use of NIBP channel with leaking cuff hose fittings may result in inaccurate non-invasive blood pressure measurements.

1. Disconnect the cuff hose from the monitor.

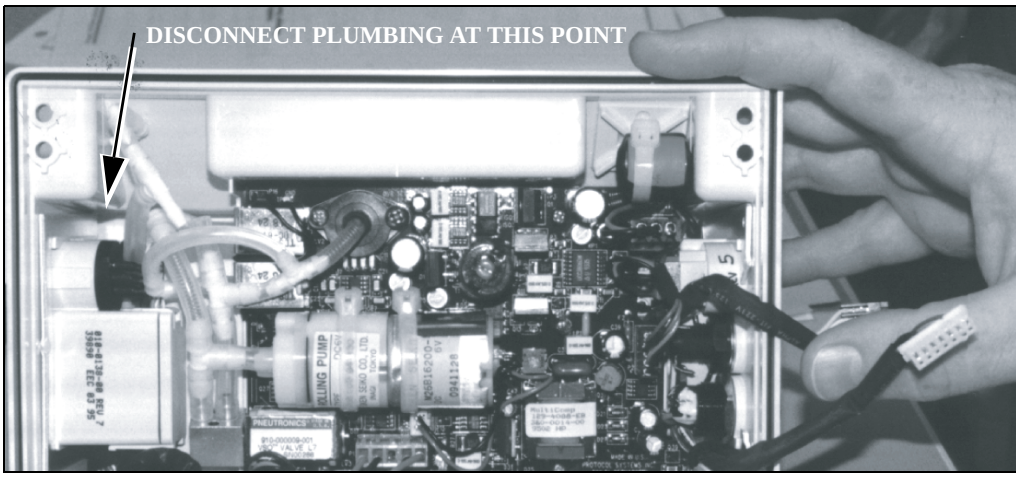


2. Using pliers, pull off the metal fitting from the cuff hose.
3. Cut approximately 1/2" off the cuff hose.
4. Using a small screwdriver, remove the C-clip from the fitting.
5. Remove the knurled nut from the fitting.
6. Remove the O-ring gasket and replace it with a new one, being careful not to nick or otherwise damage the new O-ring.
7. Reassemble the fitting with the knurled nut and C-clip.
8. Press the fitting back onto the cuff hose.

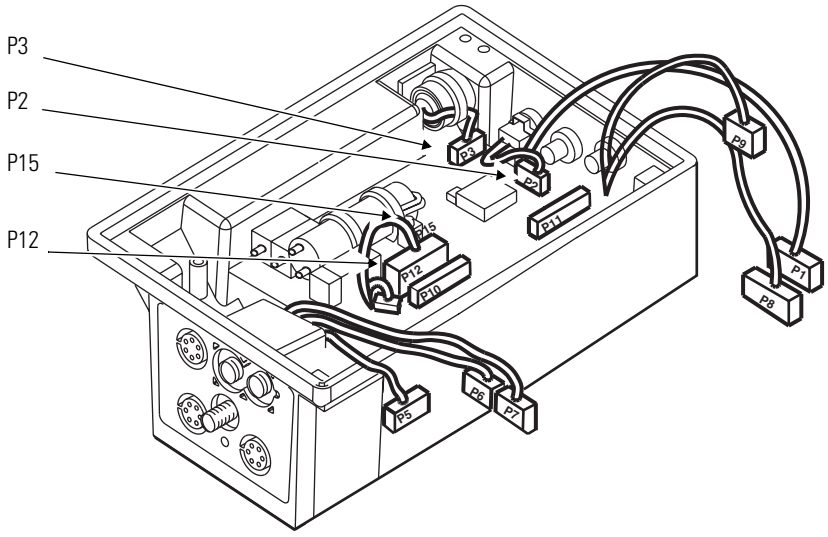
Replacing the Recharger Board

The Recharger Board is secured to the Rear Chassis by four screws. When removing the Recharger Board, note the location of cables, plumbing, and screws and screw lengths.

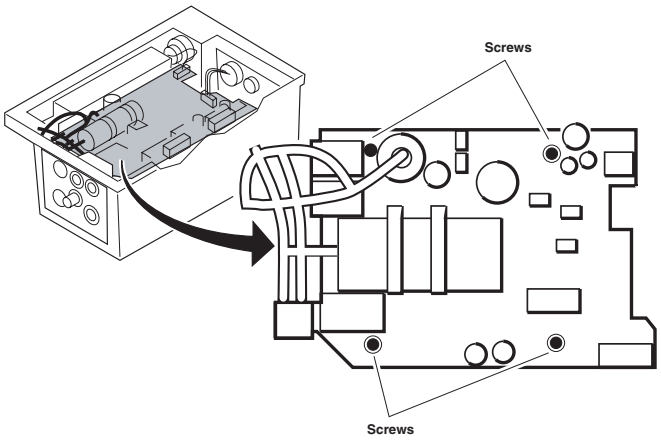
1. Remove the battery pack ("Removing the single battery pack" on page 66).
2. Open the monitor ("Opening the monitor" on page 68). (Remove the Rear Chassis from the Interface Chassis).
3. Disconnect the air tubing attached to the valves and pump at the junction indicated below.



4. Disconnect cables P2, P3, P12, and P15 from the Recharger Board. Note cable routing for reinstallation.



5. Remove the four screws securing the Recharger Board to the Rear Chassis. Note the screw passing through the pressure transducer is longer than the three that pass through the Board only.



6. Lift out the Recharger Board.

Caution As you set the Recharger Board in place during installation, keep the Board away from the power switch solder terminals to avoid binding against them. The terminals may become damaged if force is applied against them.

When installing the Recharger Board:

- blow out any dust and particulates using pressurized de-ionized gas
- move all cables out of the way
- torque screws to 3.8 in-lb to 4.2 in-lb (0.43 N-m to 0.47 N-m)

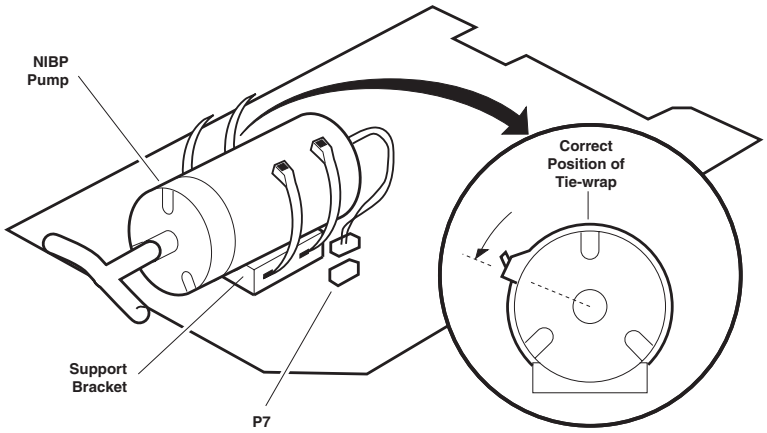
Replacing the pump

New wires and a connector are provided with the replacement pump kit.

1. Remove the battery pack ("Removing the single battery pack" on page 66).
2. Open the monitor ("Opening the monitor" on page 68).
3. Remove the Recharger Board ("Replacing the Recharger Board" on page 83).
4. Unplug the pump cable from the Recharger Board.
5. Disconnect the tubing from the pump.
6. Cut the tie wraps securing the pump to the Recharger Board.
7. Lift the pump from the Board, and remove the old tie wraps from the support brackets.

When installing a pump:

- Slide new tie wraps into support brackets as shown in the figure below.
- Set the pump onto the Recharger Board.
- Secure the pump to the Recharger Board with tie wraps, aligning the fastener ends as shown in the figure below and cutting off the excess.
- Plug in the pump cable to connector P7 on the Recharger Board.



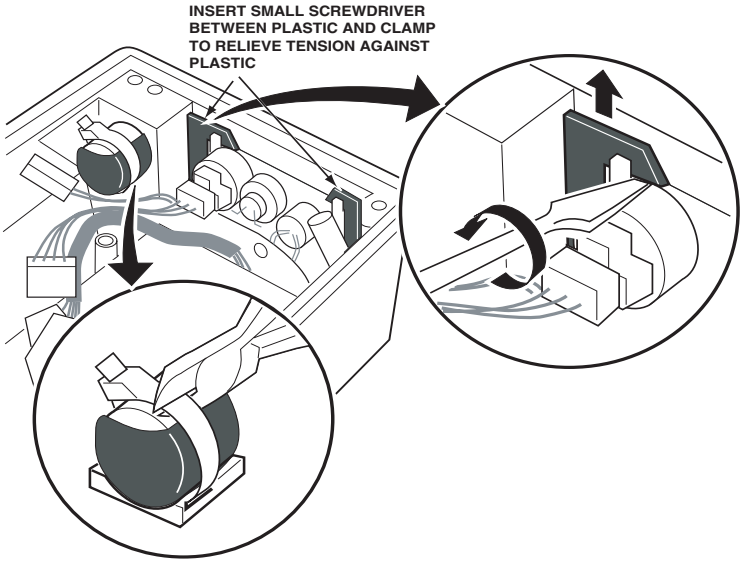
Replacing the side panels

The Propaq CS monitor side panels are complete assemblies.

The side panels are sealed to the Rear Chassis with an adhesive gasket. A new gasket is provided with the new side panel kit.

Removing the right side panel

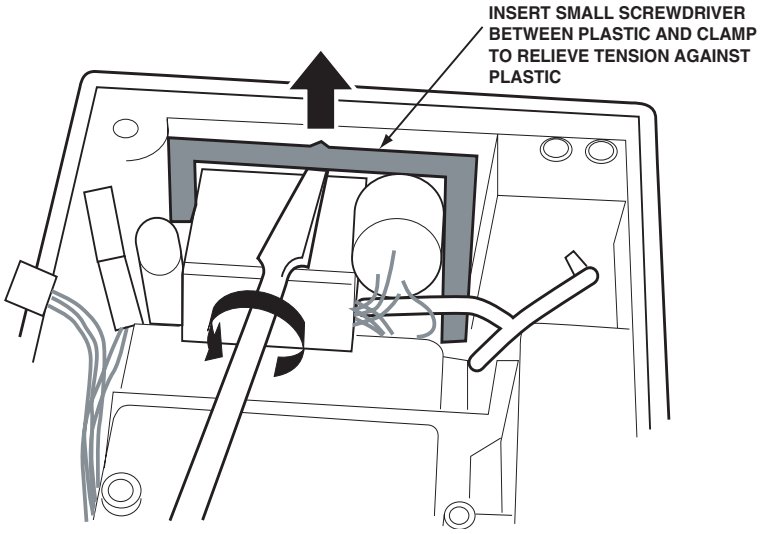
1. Remove the battery pack ("Removing the single battery pack" on page 66).
2. Open the monitor ("Opening the monitor" on page 68).
3. Remove the Recharger Board ("Replacing the Recharger Board" on page 83).
4. Cut and remove the tie wrap securing the bead connected to the side panel.



5. Remove the two right side panel clamps by inserting the end of the flat blade screwdriver under the clamp and gently rotating the blade to loosen the clamp. Then slide the clamp out.
6. Press the side panel out of the Rear Chassis. There is an adhesive gasket around the side panel which requires considerable force to separate. **Do not pry against components**.

Removing the left side panel

1. Remove the battery pack ("Removing the single battery pack" on page 66).
2. Open the monitor ("Opening the monitor" on page 68).
3. Remove the Recharger Board ("Replacing the Recharger Board" on page 83).
4. Remove the U-shaped clamp that secures the left side panel assembly by inserting a small screwdriver between the clamp and plastic and the end of another flat blade screwdriver under the clamp and gently rotating the blade to loosen the clamp. Then slide the clamp out.



5. Press the side panel out of the Rear Chassis. There is an adhesive gasket around the side panel which requires considerable force to separate. **Do not pry against components**.
6. Remove the tubing attached to the cuff hose connector. You can reuse this tubing when installing the new side panel.

Installing side panels

1. Clean all gasket material from the Rear Chassis where the side panel is to be installed. (The adhesive side of duct tape can be used to pull away old gasket residue.)
2. Attach the tubing to the NIBP cuff hose connector.
3. Route the bundle of cabling with the bead under the temperature connector housing so that when the side panel is installed the connectors will extend out of the Rear Chassis along the bottom of the Chassis. (See the figure below.)

Note Uncovering the protective paper in the next step exposes the adhesive on the gasket. Do not touch or otherwise contaminate the adhesive, or the adhesive may not properly seal the side panel.

4. On the new side panel, remove the protective paper from the gasket attached to the side panel.

Note When installing the left side panel in the next step, slightly bend up wires at the P1 and P2 pressure connector pins to allow proper fit.

5. Set the side panel in place.

   Make sure the side panel completely sets in place (it should be flush with the exterior of the Rear Chassis). If not properly fitted, the clamp securing the side panel will not seat.

6. Apply slight pressure to seal the side panel in the Rear Chassis.

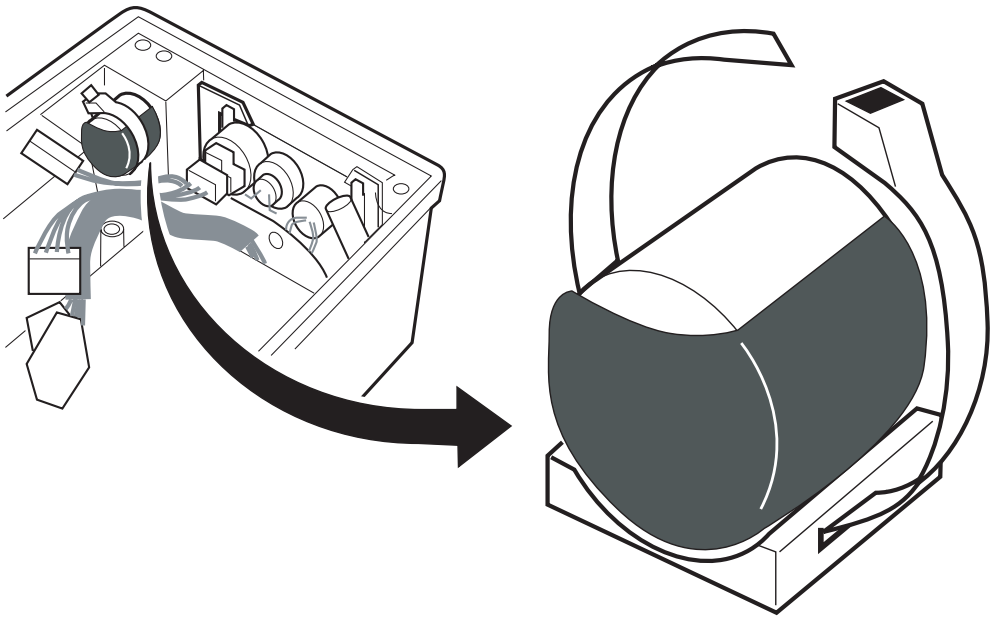
Caution Do not force the clamp in the next step. Forcing it may damage the side panel or Rear Chassis.

7. Slide the clamp(s) in place with the detent facing the Chassis plastic so that it presses against the Chassis.

   If the clamp requires excessive pressure to slide in place, remove the clamp and check the side panel to be sure it is completely seated.

8. Connect all plumbing and cables.

9. When installing the right side panel, install a new tie wrap to secure the bead to the Rear Chassis (see below).

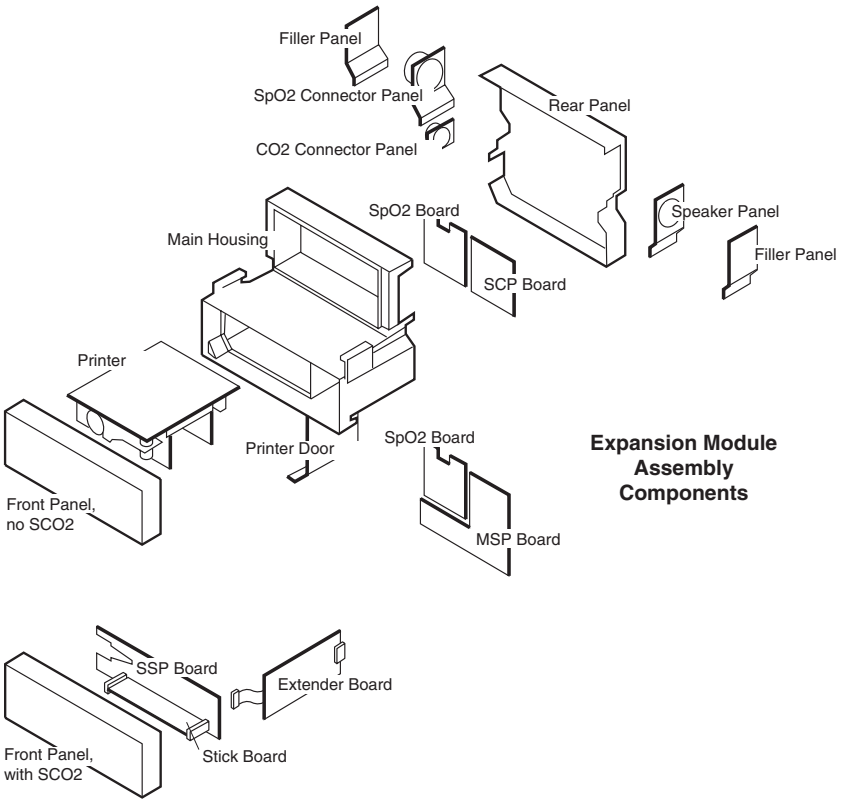


Expansion Module

The Expansion Module housing contains one or all of the following (see below):

- printer mechanism with Printer Main Board
- MSP Board (units with CO_2 option)
- CO_2 connector side panel
- SCP/SpO_2 Board (units with printer and SpO_2 options)
- SpO_2 connector side panel
- SpO_2 speaker side panel
- front panel assembly with pushbuttons
- SSP Board (units with Sidestream CO_2)
- Stick Board (units with Sidestream CO_2)
- Extender Board

Note For specific option configurations, refer to drawings in "Monitor options" on page 106.



Expansion Module Assembly Components

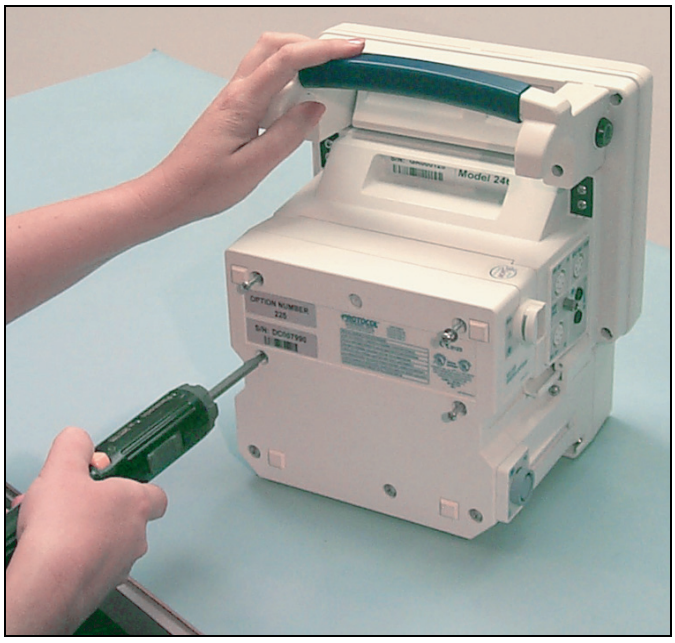
Note The Expansion Module does not need to be separated from the monitor to replace the Expansion Module front panel.

Opening Expansion Module rear panel

1. Separate the monitor and Expansion Module ("Removing the dual battery in expansion module" on page 66).

Note For all Sidestream CO_2 options (226, 227, 228, or 229) remove the front panel ("Replacing Expansion Module front panel" on page 93) and the extender board ("Replacing the Extender Board" on page 100) before proceeding with the rear panel removal.

2. Remove the four screws securing the rear panel to the Expansion Module Chassis (see below).



Caution When disconnecting the expansion cable connector in the next step, note that it has two plastic securing clips that must be separated from the connector. These clips are fragile and should be handled carefully.

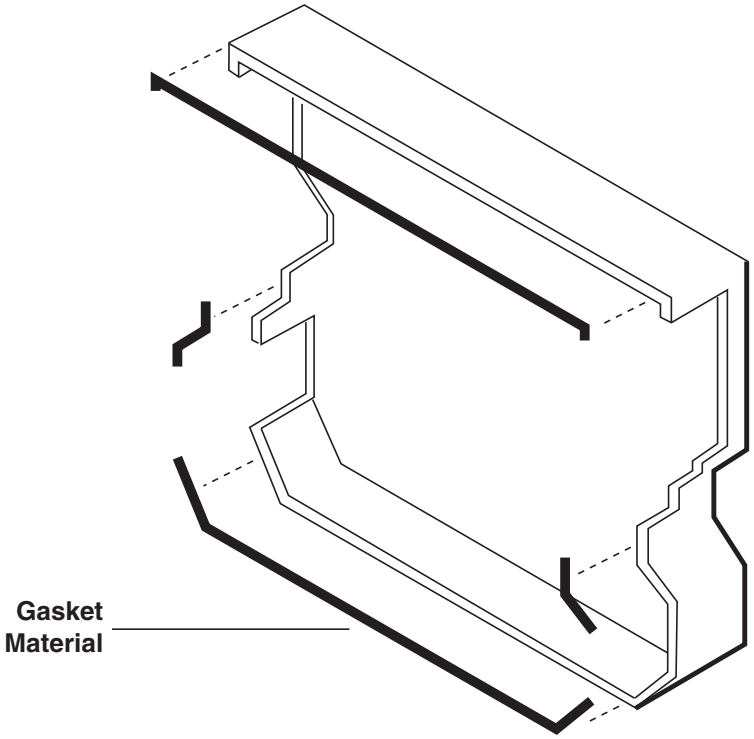
3. Separate the rear panel from the Chassis a few inches (keep any side panels with the rear). Then disconnect the expansion cable connector and the printer cable connector from the circuit board (SCP or MSP Board) in the rear panel.

4. Remove the rear panel with the side panels in place.

Note The rear panel is sealed to the Chassis with rubber gaskets around the perimeter of the rear panel. These gaskets can be reused when reassembling the Expansion Module. Save these gaskets. Also, spacers might not be secured to the rear panel and can fall out. As the unit is disassembled set aside the spacers for reuse during reassembly.

Closing Expansion Module

1. Make sure all cables are in place and the gaskets removed earlier are available.
2. Set the rubber gaskets in their proper places as shown in the figure below.
3. Connect the printer cable and expansion cable to the SCP or MSP Board.



4. Set the Chassis onto the rear panel, confirming that the gaskets don't slip out of a channel and become pinched between the rear panel and the Chassis.

Caution To prevent damage to the Expansion Module Chassis, make sure that the spacers are in place. The Chassis may crack if screws are tightened without the spacers in place. Note that the five upper spacers are not used when the SpO_2 module is present.

5. Torque screws to 4.75 to 5.25 in-lb (0.54 to 0.59 N-m).

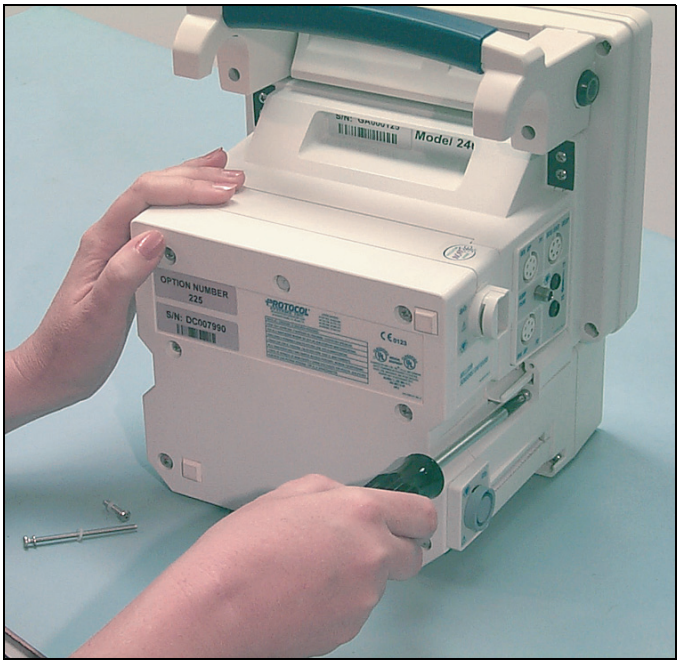
Replacing Expansion Module front panel

The front panel contains the printer buttons. Like the rear panel, the front is sealed to the Chassis with a rubber O-ring gasket. This gasket can be re-used when replacing the front panel.

The Expansion Module front panel is attached to the Chassis with four screws. Use the following procedure to remove the front panel:

1. Remove the four screws (see the figure below) holding the front panel.
2. For Expansion Module options with Sidestream CO_2 (226, 227, 228, or 229), disconnect the cables from J1 and J3 on the SSP Board.

Note To replace the Sidestream CO_2 assemblies, see "Replacing the Sidestream CO2 assemblies" on page 100.



3. Separate the front panel from the Chassis, disconnecting the front panel cable from the Expansion Module button board.

   A rubber O-ring gasket seals the front panel to the Chassis. Save this gasket to re-install it on the front panel.

When installing the Expansion Module front panel:

- Verify the O-ring gasket is in place and not pinched.
- Torque screws to 6.65 to 7.35 in-lb (0.75 to 0.83 N-m)

Replacing Expansion Module button board and buttons

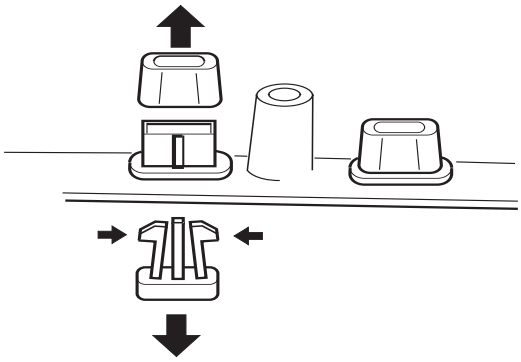
The Expansion Module contains a button board that has electrical contact areas to detect when an Expansion Module button is pressed. The front panel buttons are similar to the monitor buttons. A plastic button and flexible contact touches the contact area on the button board when a button is pressed.

Use the following procedure to remove the button board and buttons:

1. Remove the Expansion Module front panel ("Replacing Expansion Module front panel" on page 93).
2. Remove the two screws securing the button board to the front panel.
3. Remove the button board.

Note Do not touch the contact areas on the button board or the contact inside the flexible contacts. Touching these areas may deposit oil on them, reducing the ability of the parts to make electrical contact. If you touch these areas, clean them with a cotton swab moistened with isopropyl alcohol.

4. To remove each button, gently lift out the rubber portion of the button contact attached to the inside of the front panel, then squeeze together the stem ends of the button from the inside of the front panel while gently pushing it out of the button channel.



When installing the button board,

- make sure all buttons are completely installed
- make sure the rubber button contact is seated onto the channel
- torque screws to 4.75 to 5.2 in-lb (0.54 to 0.59 N-m).

Replacing the printer

This section provides instructions on removing and installing the printer mechanism and Printer Main Board. These two components are provided as a replacement unit called the Printer Assembly.

Caution Do not attempt to separate the printer mechanism from the Printer Main Board. Replace these as a unit.

Removing printer

Remove the Printer Assembly according to the following instructions.

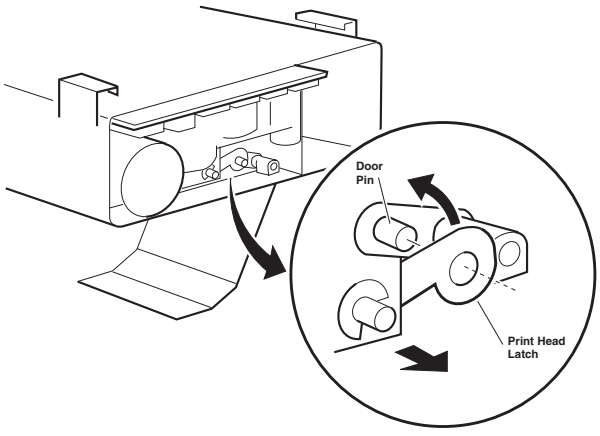
1. Remove any printer paper.
2. Open the Expansion Module ("Expansion Module" on page 90).
3. Remove the Expansion Module front panel ("Replacing Expansion Module front panel" on page 93).
4. Disconnect the front panel button cable from the front of the Printer Main Board.

Caution When removing the shield in the next step, be careful not to tear it. The shield is held in place by double-sided adhesive pads.

5. Carefully remove the plastic shield from the rear of the Expansion Module Chassis. Set this shield aside.
6. Disconnect the battery cable and printer cable from the rear of the Printer Main Board.
7. Lay the Chassis on its back.
8. Completely open the paper door.

Caution As you remove the Printer Assembly from the Chassis in the next step, rotate the printer door latch mechansim counter-clockwise to clear the Chassis.

9. Carefully slide the Printer Assembly out the front of the Chassis. The Printer Assembly fits snugly, requiring some force to slide it out, and the door latch mechanism must be rotated counter-clockwise after it disengages from the printer door pin (see below).

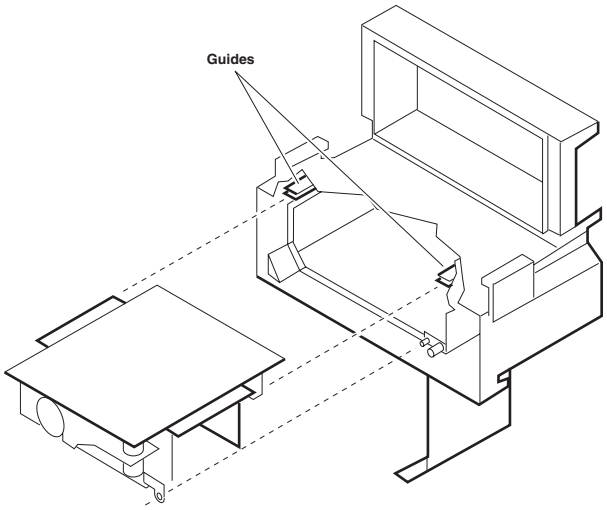


Installing the printer

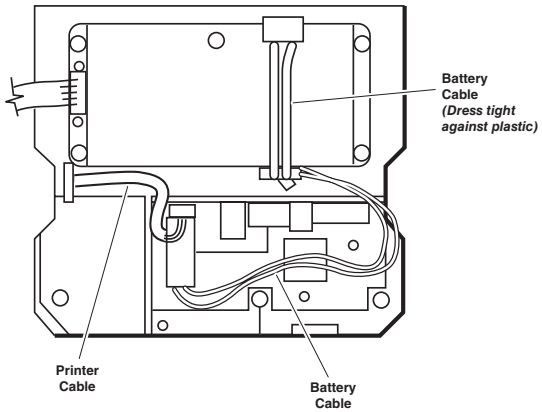
1. Lay the Chassis on its back
2. Completely open the paper door.

Caution As you install the Printer Assembly, rotate the printer door latch mechansim out of the way so it clears the Chassis. The Printer Assembly fits snugly, but should not require much force to slide it in place.

3. Slide the Printer Assembly into the guides as shown below, making sure that after the door latch mechanism clears the chassis you rotate it clockwise to engage the printer door pin. (Also see the figure above.)



4. Carefully close and open the door a couple times to check that the door pin and latch mechanism function without binding.
5. Connect the battery cable and printer cable to the Printer Main Board. It is important to properly dress the cables as shown below.

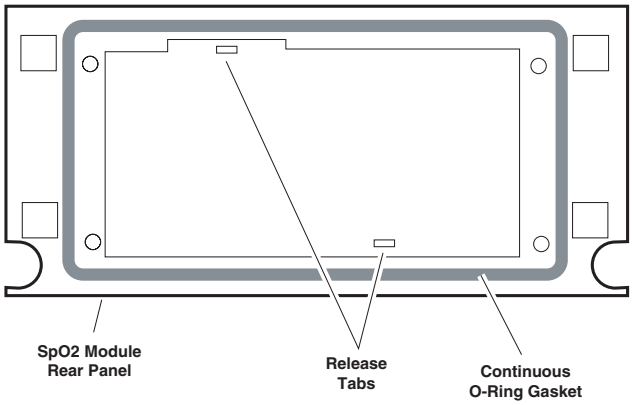


6. Connect the button cable to the front of the Printer Main Board.
7. Install the Expansion Module front panel, close the Expansion Module, and reattach it to the monitor.

Opening the SpO_2 Module

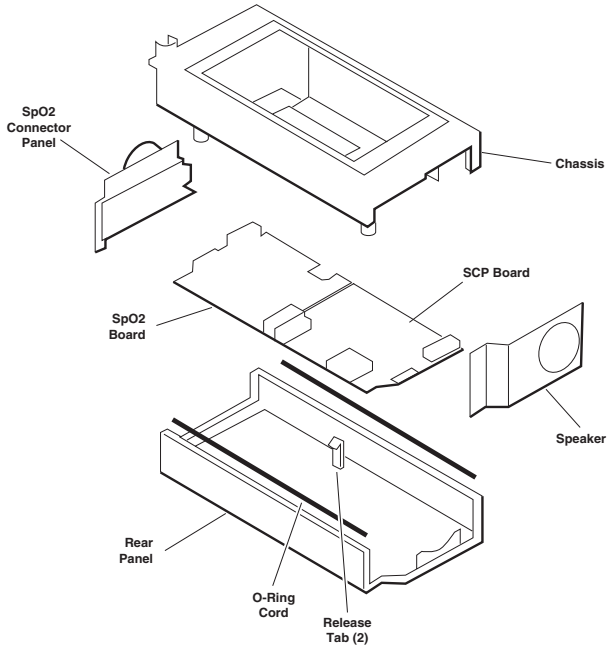
1. Separate the SpO_2 module from the monitor according to the procedure "Removing the dual battery in expansion module" on page 66.

2. Two tabs secure the SpO_2 module rear panel to the SpO_2 module chassis. Using a small screwdriver or your finger, press on each of the tabs inside the SpO_2 module chassis while applying pressure to separate the rear panel from the chassis. (When separating the rear panel from the chassis, make sure the side panels remain seated in the rear panel.)



3. After the tabs allow the rear panel to be removed, separate the rear panel from the chassis.

   The rear panel is sealed to the chassis with rubber O-ring gaskets. These gaskets can be reused when re-assembling the SpO_2 module.



When closing the SpO_2 module, confirm that no O-ring gasket slips out of its channel and becomes pinched between the rear panel and the Chassis.

Replacing the SpO_2 Boards

The following instructions describe how to replace the two SpO_2 Boards in the SpO_2 module and in the Expansion Module without a CO_2 option. Instructions for replacing SpO_2 Boards in an Expansion Module with a CO_2 option are described in "Replacing the MSP/SpO2 Boards" on page 99.

Caution When replacing the SpO_2 Boards, remove both boards with the patient connector side panel still connected. Attempting to disconnect the patient connector side panel from the SpO_2 Board before removing both boards with the side panel can damage the flex-cable between the side panel and the SpO_2 Board.

1. Open the SpO_2 Module ("Opening the SpO2 Module" on page 97) or the Expansion Module ("Expansion Module" on page 90).

Caution In the next step, the connector securing clips are fragile and will break if not handled carefully.

2. Disconnect the cable(s) from the SpO_2 SCP Board by carefully releasing the securing clips and unplugging the connectors.
3. Disconnect the speaker cable from the SCP Board.
4. Remove the speaker side panel from the chassis.
5. Remove the one or two screws securing the SCP Board and SpO_2 Board to the rear panel.
6. Lift out the two boards and patient connector side panel as a unit. (The side panel easily slides out.)
7. Using equal pressure on both sides of the connector, disconnect the patient connector side panel connector from the SpO_2 Board.
8. Disconnect the two boards by gently pulling them apart.

When installing the SpO_2 Boards first, plug the two boards together. Then:

- Connect the patient connector side panel connector to the SpO_2 Board.
- Set the two boards and side panels in place, making sure that the boards are seated on the support tabs.
- Torque screws to 4.75 to 5.25 in-lb (0.54 to 0.59 N-m).
- Reconnect the printer and expansion cables to the SCP Board.

Replacing the MSP/SpO_2 Boards

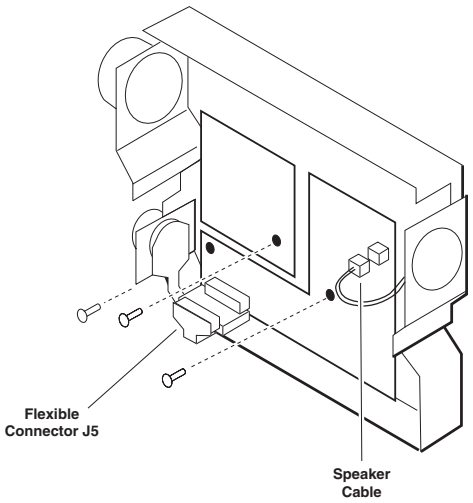
The following instructions describe how to replace the MSP/SpO_2 Boards in the Expansion Module with a CO_2 option. Instructions for replacing SpO_2 Boards in SpO_2 module and Expansion Module without a CO_2 option installed are described in "Replacing the SpO2 Boards" on page 98

Caution When replacing the MSP/SpO_2 Boards, remove both boards with the patient connector side panel still connected. Attempting to disconnect the patient connector side panel from the SpO_2 Board before removing both circuit boards with the side panel can damage the flex-cable between the side panel and the SpO_2 Board.

1. Open the Expansion Module ("Expansion Module" on page 90).

Caution In the next step, the connector securing clips are fragile and will break if not handled carefully.

2. Unplug the flex-cable connector J5 from the MSP Board, but do not attempt to remove the Mainstream CO_2 connector side panel.



3. Disconnect the speaker cable from the MSP Board and remove the speaker side panel.
4. Remove the three screws securing the MSP Board and SpO_2 Board to the rear panel (see the figure above).
5. Lift out the two circuit boards and SpO_2 patient connector side panel as a unit. (The side panel easily slides out.)
6. Using equal pressure on both sides of the connector, disconnect the patient connector side panel connector from the SpO_2 Board.
7. Disconnect the two circuit boards by gently pulling them apart.

When installing the MSP/SpO_2 Boards:

- plug the two circuit boards together
- connect the patient connector side panel connector to the SpO_2 Board

- set the two boards and side panels in place, making sure that the boards are seated on the support tabs
- torque screws to 4.75 to 5.25 in-lb (0.54 to 0.59 N-m)
- reconnect the Mainstream CO_2 patient connector cable

Replacing the Sidestream CO_2 assemblies

The following instructions describe how to replace the Sidestream CO_2 option assemblies in the Expansion Module. These include the Sidestream Processor (SSP) Board, the Sidestream CO_2 "Stick" Board, and the Extender Board.

1. Loosen the Expansion Module front chassis ("Expansion Module" on page 90).
2. Disconnect J1 and J3 from the SSP Board to completely separate the Front Chassis.

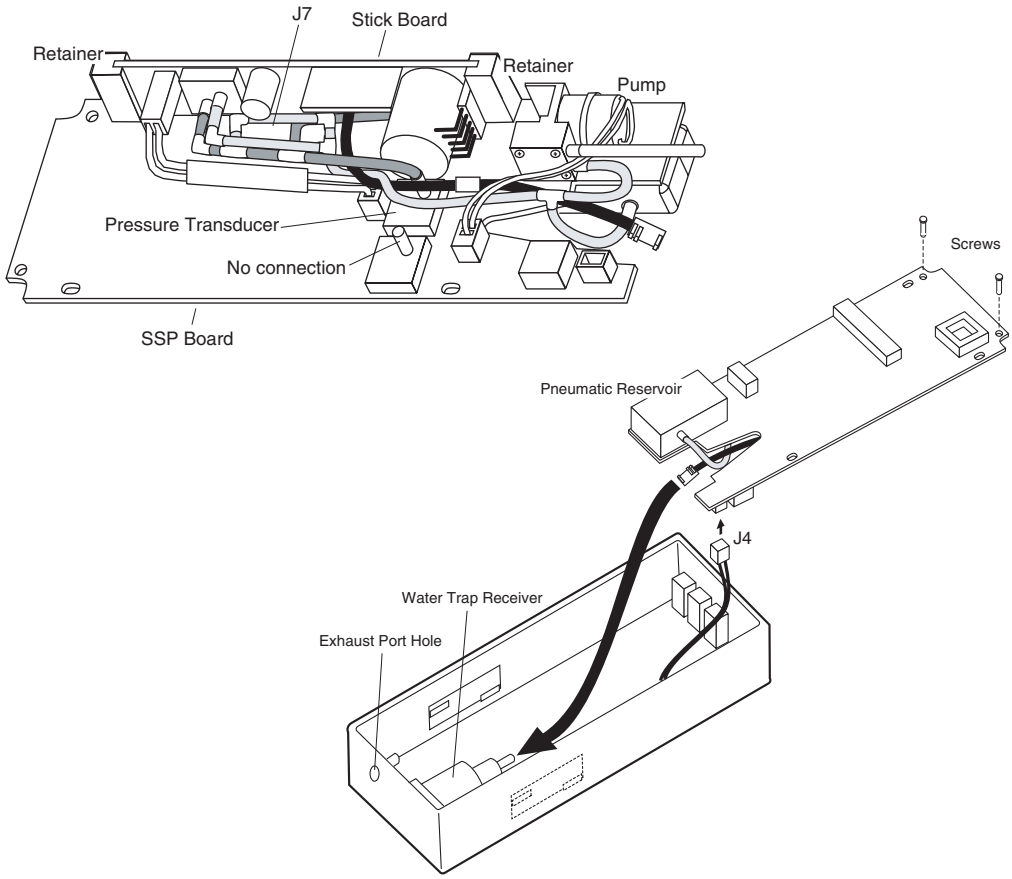
Replacing the Extender Board

1. Remove the Extender Board from the MSP Board through the left card slot in the Expansion Module.

When reinstalling the Extender Board, observe P6 connector mating while installing through the left card slot to ensure proper connection with the MSP Board.

Removing the SSP/Stick Board assembly

Caution When servicing the SSP and Stick Board assemblies, be sure to note the tubing routing prior to disconnection. Always reassemble tubing exactly as removed.



1. Remove the two screws located on the right edge of the SSP Board (as viewed from the front).
2. Tilt the loosened right edge of the SSP Board assembly (with interconnected Stick Board) up, away from the mounting screw posts far enough to allow access to the tubing connections under the board.
3. Disconnect the tubing from the water trap receiver and exhaust port using rounded, non-serrated pliers only. Disconnect the water trap switch connector from J4.
4. Lift the SSP/Stick assembly up and out of the front chassis plastic, clearing all board components from the retaining tabs on the insides of the front chassis plastic as the assembly is removed.

Removing the Stick Board from the SSP Board

1. Disconnect the tubing from the pump and pressure transducer PT2 on the front-facing side of the SSP Board and the pneumatic reservoir on the rear-facing side.
2. Remove the two screws from the front-facing side of the SSP Board that secure two slotted nylon Stick Board retainers.
3. Pull the Stick Board up to free it from connector J7 and remove it from the SSP Board. For Stick Board replacement purposes, leave all tubing as removed connected to the Stick Board.

When reconnecting the Stick and SSP Boards:

- reconnect the two Boards (connector J7)
- install retainers onto Stick Board
- install screws into retainers to secure the Stick Board (torque to 2.5 in-lb or 0.28 N-m)
- reconnect tubing to the pump, transducer PT2, and the pneumatic reservoir (route tubing exactly as removed)

When reinstalling the SSP/Stick Assembly into the front panel:

- reconnect water trap switch to J4 on the SSP Board
- from a vertical position, insert left edge of SSP Board into retaining tabs on the inside of the front panel plastic
- align tubing as originally configured to allow access for connections and to prevent pinching
- connect tubing to the water trap, using rounded, non-serrated pliers only

WARNING Failure to connect the exhaust post tubing may allow concentration of oxygen inside of the monitor and create a potential explosion risk.

- lower the right side of the SSP/Stick Assembly and slide the left side into the retaining tabs to properly seat the Boards into the front panel assembly (check all tubing and cable routing to make sure that none are pinched).
- connect exhaust port tubing, using rounded, non-serrated pliers only
- secure screws through SSP Board to front panel (torque to 5.0 in-lb or 0.56 N-m)

When reinstalling the front panel on the Expansion Module:

- connect J1 and J3 to the SSP Board
- route printer cable in front of printer motor
- fit front panel to the main Expansion Module Chassis
- secure front panel with four screws (torque to 3.5 in-lb or 0.40 N-m)

WARNING To ensure that all tubing is properly connected after servicing SCO_2, perform the "Sidestream CO2 verification procedure" on page 36 when complete.

Replacing Expansion Module side panels

The side panels easily slide out after the Chassis and rear panel are separated. If the patient connector side panel is being replaced, this side panel and the two boards must be removed together before disconnecting the side panel from the board. (See "Replacing the SpO2 Boards" on page 98 or "Replacing the MSP/SpO2 Boards" on page 99.)

If the speaker side panel is being replaced, separate the chassis and rear panel as described earlier in this section, disconnect the speaker from the SCP or MSP Board, and slide out the speaker side panel.

Acuity Option repair procedures

Repair of the Acuity Hardwired Option

The circuitry for the Acuity hardwired option is located on the Digital Board. The supporting circuitry and the socket for the Symbol Radio PCMCIA Card/Antenna Assembly for the Acuity wireless option is located on the Digital Board. See "Replacing the Display" on page 75.

Replacing the radio card

Note To determine the radio card configured in your monitor, check the label on the expansion module. If the label contains the following symbol

, replace the radio with a 5 GHz radio card.

Caution The 2.4 GHz and 5 GHz radio cards are not interchangeable. Replacement of the radio card in the wrong configuration will cause permanent damage to the radio card and/or monitor hardware.

To replace the radio card, perform the following steps:

1. Open the monitor to gain access to the Front Chassis. See "Opening the monitor" on page 68.
2. Use a Phillips screwdriver to remove the five screws securing the Interface Chassis to the Front Chassis.
3. Pull the top edge of the Interface Chassis away from the Front Chassis about two inches to gain access to the radio card/antenna assembly.
4. Slide out the radio/antenna assembly from the Digital Board. Slide the replacement radio/antenna assembly into the card socket on the Digital Board.
5. Reassemble the monitor.

7 Technical overview

Introduction

This section describes the electronics of the Propaq CS monitor and three of its options: Printer, Pulse Oximetry (SpO_2), and Capnography (CO_2).

This section is intended as an aid to servicing at the field replaceable unit level and contains only system-level and functional-level circuit descriptions.

When replacing modules or components, refer to "Repair procedures" on page 59. Part numbers are identified in "Field Replaceable Units (FRUs)" on page 129.

System description

The Propaq CS monitor can be configured as a stand-alone monitor or with one of two optional housings containing different monitoring and printer options. The figures on the following pages illustrate the possible housing configurations.

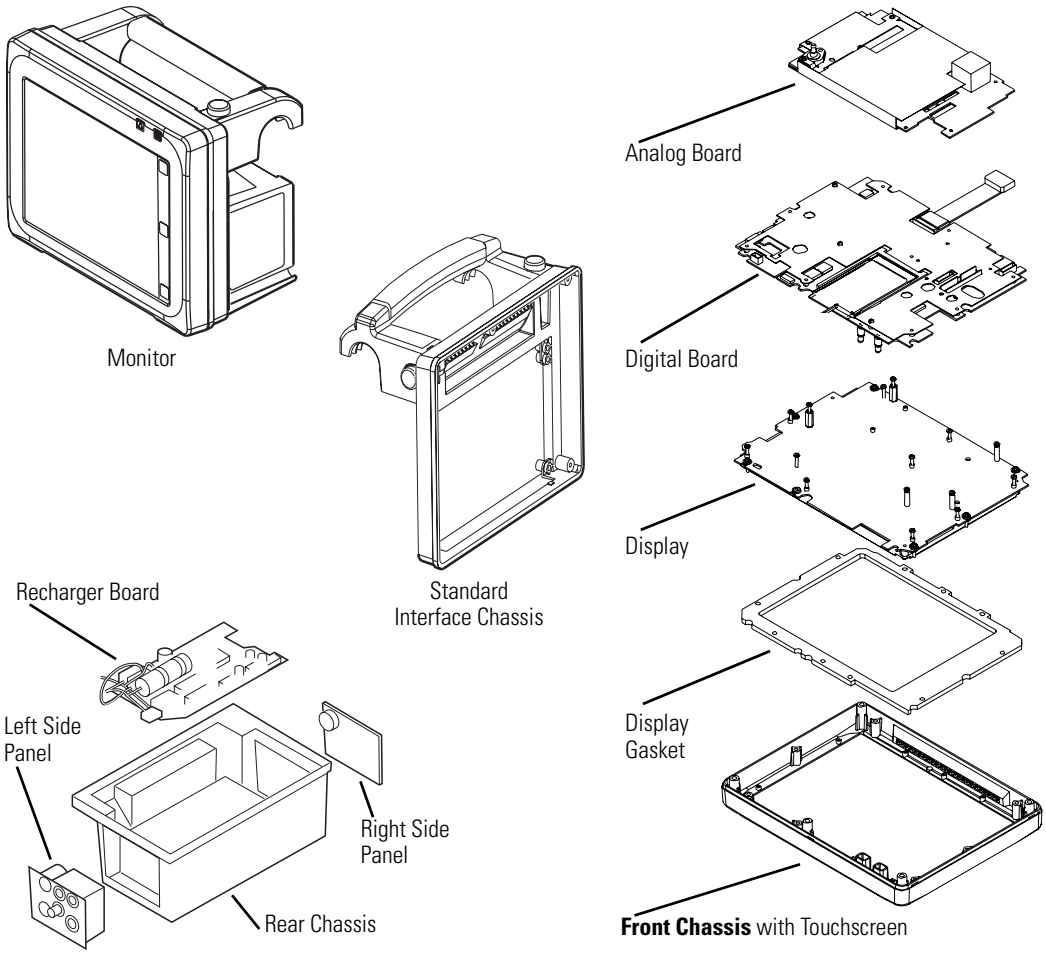
The main functional modules (e.g. Analog Board, Recharger Board, Printer, SCP Board, etc.) reside in the housings. The figures on the following pages illustrate the location of the main functional modules in the Propaq CS monitoring system housings.

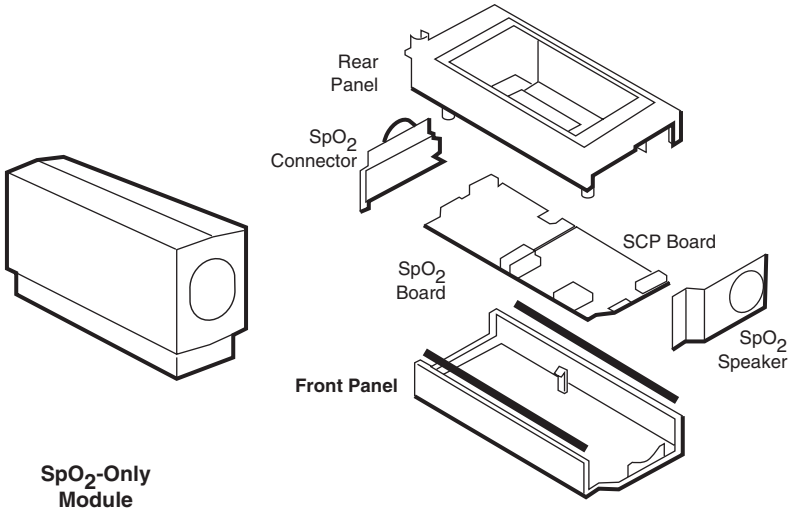
The monitor electronics reside on three circuit boards within the monitor housing (front and rear chassis). Additional circuitry for the printer and optional monitoring parameters reside on additional circuit boards housed in the expansion modules.

The monitor system block diagram is shown on page 110.

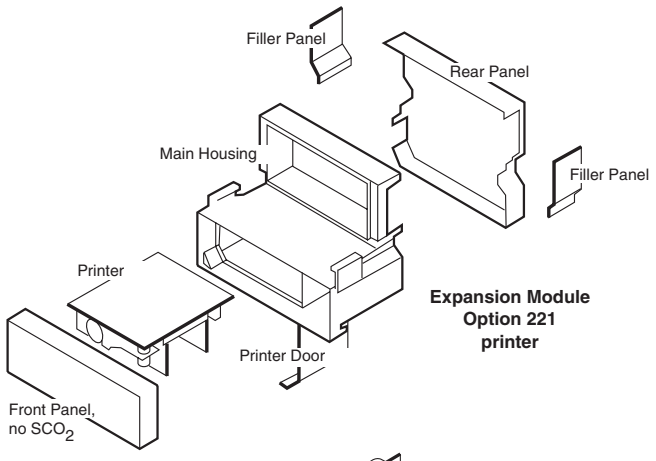
The monitor electronics consist of the power system, monitoring electronics, and the cuff pneumatics.

Monitor options

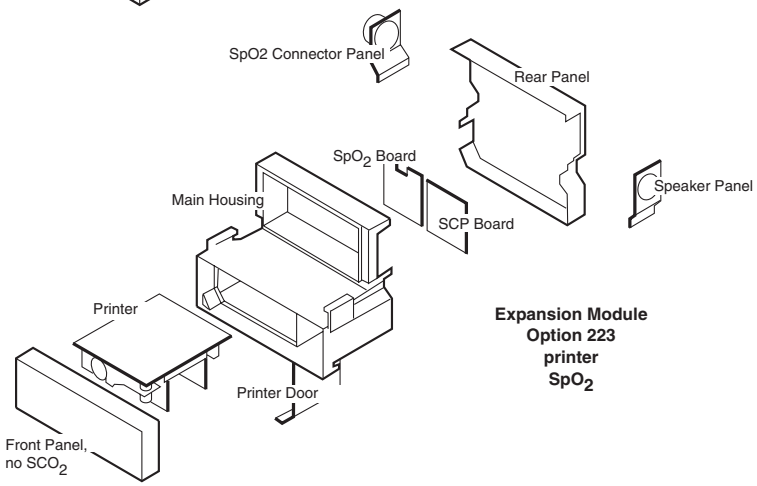




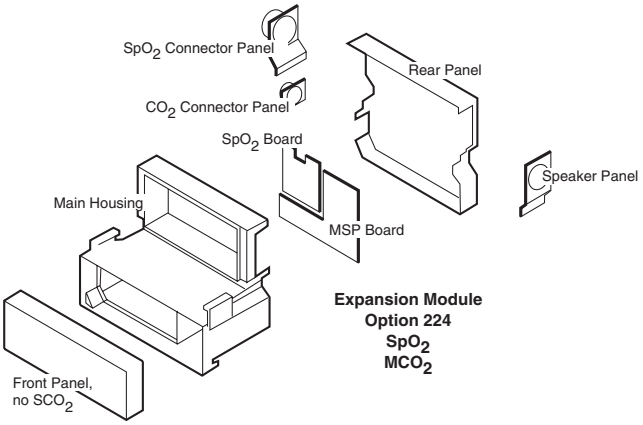
SpO$_2$-Only Module Option 210



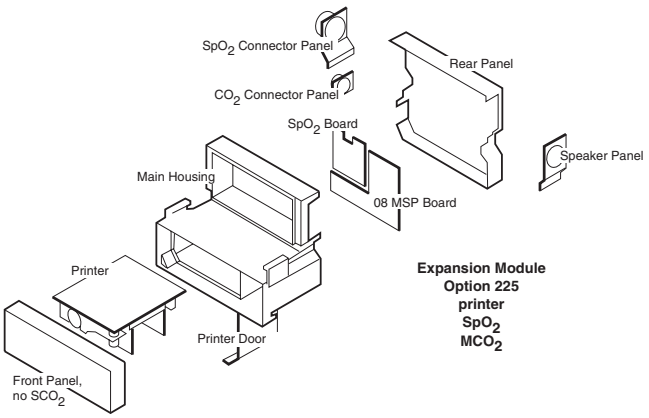
Expansion Module
Option 221
printer



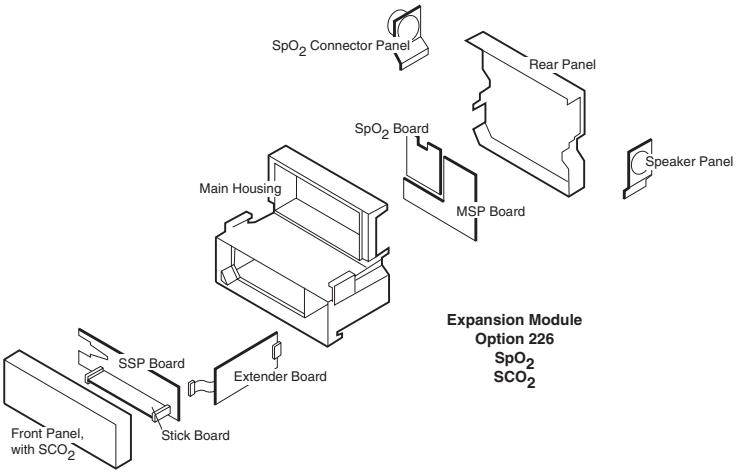
Expansion Module
Option 223
printer
SpO_2



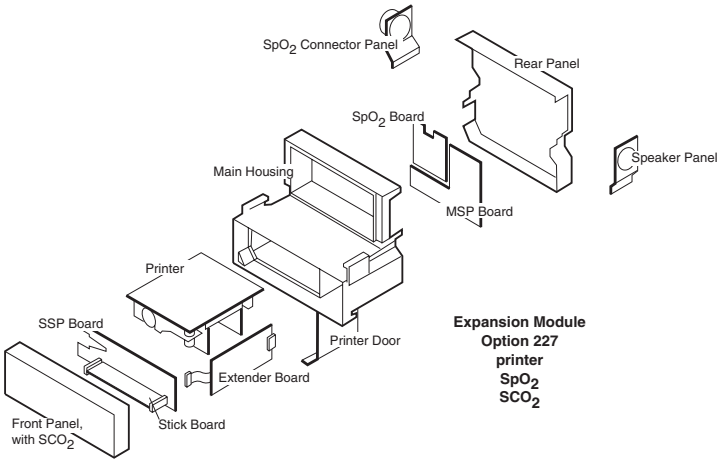
Expansion Module
Option 224
SpO_2
MCO_2



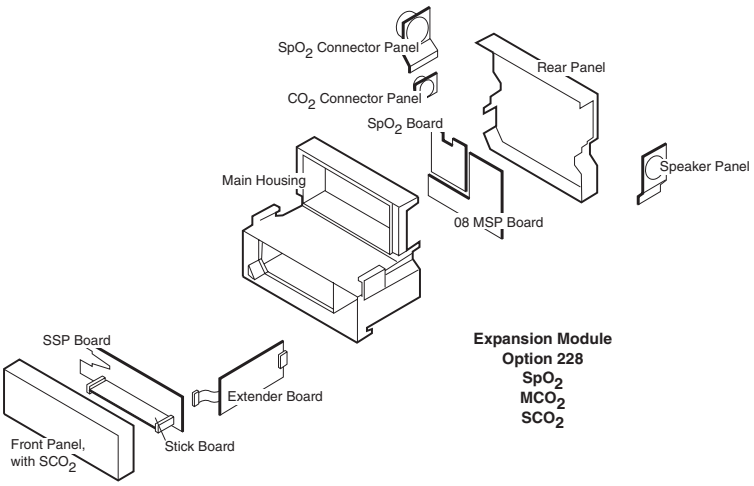
Expansion Module
Option 225
printer
SpO_2
MCO_2



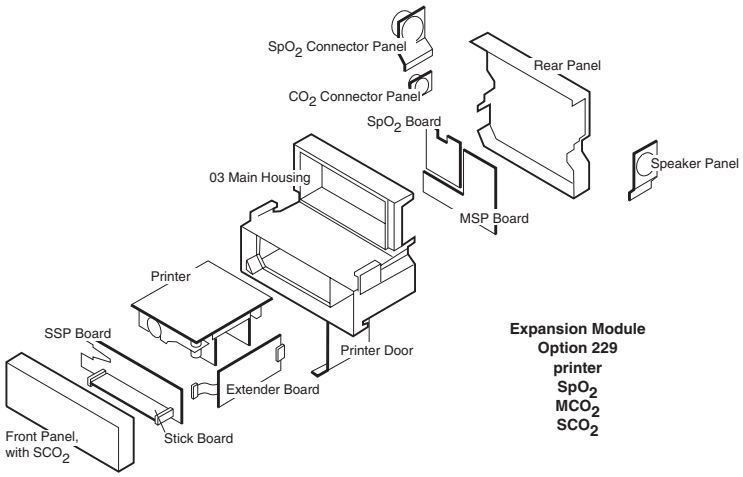
Expansion Module
Option 226
SpO_2
SCO_2



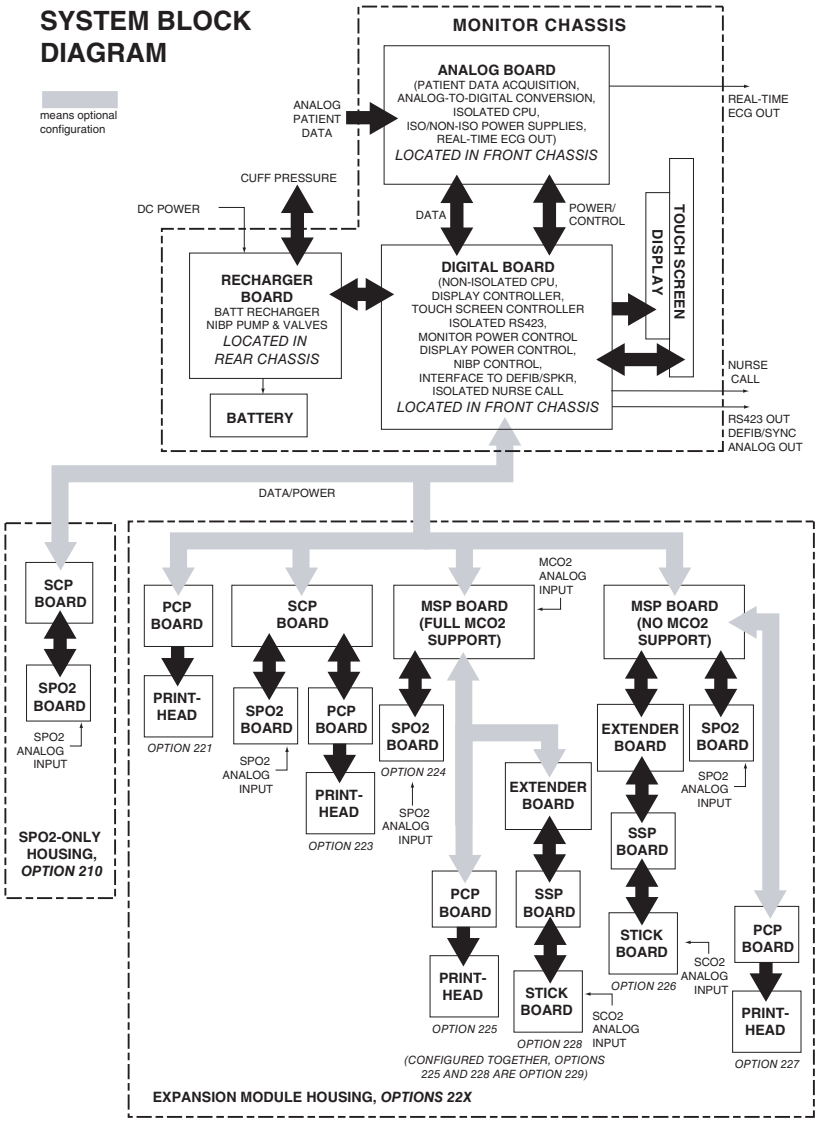
Expansion Module
Option 227
printer
SpO_2
SCO_2



Expansion Module
Option 228
SpO_2
MCO_2
SCO_2



Expansion Module
Option 229
printer
SpO_2
MCO_2
SCO_2


SYSTEM BLOCK DIAGRAM
means optional configuration
MONITOR CHASSIS
ANALOG BOARD
(PATIENT DATA ACQUISITION, ANALOG-TO-DIGITAL CONVERSION, ISOLATED CPU, ISO/NON-ISO POWER SUPPLIES, REAL-TIME ECG OUT)
LOCATED IN FRONT CHASSIS
ANALOG PATIENT DATA
REAL-TIME ECG OUT
CUFF PRESSURE
DC POWER
DATA
POWER/ CONTROL
TOUCH SCREEN DISPLAY
RECHARGER BOARD
BATT RECHARGER
NIBP PUMP & VALVES
LOCATED IN REAR CHASSIS
DIGITAL BOARD
(NON-ISOLATED CPU, DISPLAY CONTROLLER, TOUCH SCREEN CONTROLLER ISOLATED RS423, MONITOR POWER CONTROL DISPLAY POWER CONTROL, NIBP CONTROL, INTERFACE TO DEFIB/SPKR, ISOLATED NURSE CALL
LOCATED IN FRONT CHASSIS
NURSE CALL
BATTERY
RS423 OUT
DEFIB/SYNC
ANALOG OUT
DATA/POWER
SCP BOARD
SPO2 BOARD
SPO2 ANALOG INPUT
SPO2-ONLY HOUSING, OPTION 210
PCP BOARD
PRINT-HEAD
OPTION 221
SCP BOARD
SPO2 BOARD
SPO2 ANALOG INPUT
PCP BOARD
PRINT-HEAD
OPTION 223
MSP BOARD (FULL MCO2 SUPPORT)
MCO2 ANALOG INPUT
SPO2 BOARD
OPTION 224
SPO2 ANALOG INPUT
EXTENDER BOARD
PCP BOARD
PRINT-HEAD
OPTION 225
SSP BOARD
STICK BOARD
SCO2 ANALOG INPUT
OPTION 228
(CONFIGURED TOGETHER, OPTIONS 225 AND 228 ARE OPTION 229)
MSP BOARD (NO MCO2 SUPPORT)
EXTENDER BOARD
SPO2 BOARD
SPO2 ANALOG INPUT
SSP BOARD
STICK BOARD
OPTION 226
SCO2 ANALOG INPUT
PCP BOARD
PRINT-HEAD
OPTION 227
EXPANSION MODULE HOUSING, OPTIONS 22X

Power electronics description

The power system circuits are located on the Analog, Digital, and Recharger Boards. The power system includes the ac mains power adapter. Refer to the figure below.

The power system

- converts ac mains current to dc current (external power adapter)
- recharges the internal battery pack (Recharger Board)
- generates the high voltage drive for the cold cathode backlight in the display
- converts battery power to several regulated and unregulated power supplies for both isolated and non-isolated electronics (Analog and Digital Boards)
- provides isolated power for RS423 communications (Digital Board)
- controls the activation and deactivation of the power system (Digital Board)

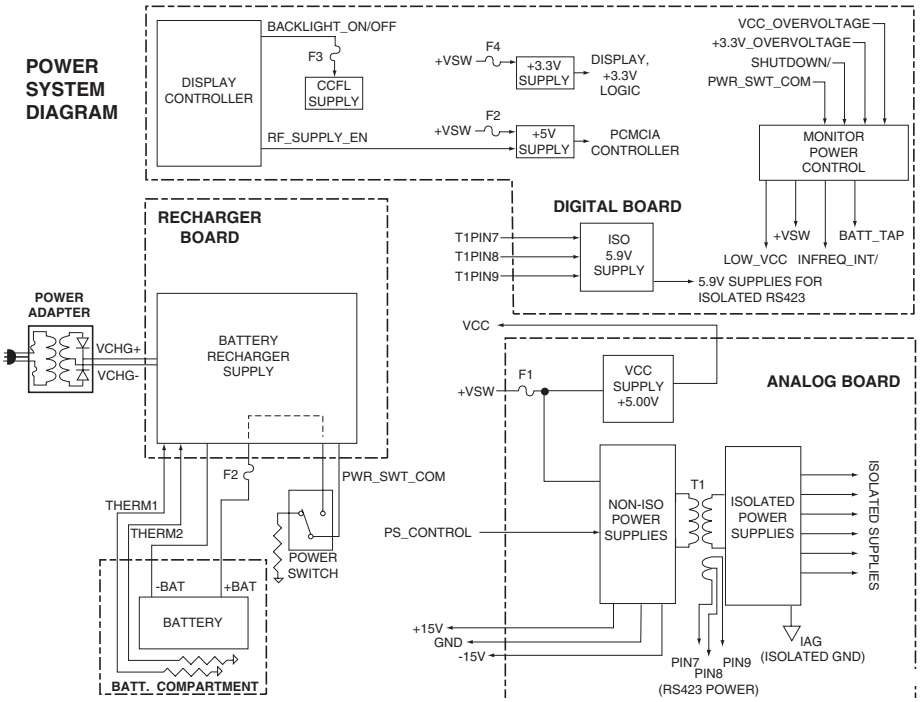
Power is delivered from ac mains to the monitor through a power adapter. The adapter converts ac to dc current at approximately 15 Volts.

The internal battery continually supplies monitor power and is recharged while the power adapter is plugged into ac mains and connected to the monitor. The monitor can also be recharged from any dc power source that meets the monitor's dc power input specifications. An accessory cable is available from Welch Allyn to allow connection of such a power source to the dc power input connector on the monitor's right side panel. This cable must be used for monitor calibration.

Thermistors in the battery compartment monitor battery temperature. As battery charging takes place, battery temperature rises. The recharger output voltage is temperature-compensated; as battery temperature rises, maximum recharger output voltage decreases.

Switching power supplies generate power for recharging the battery, for powering the display, and for other power sources throughout the monitor. Suppression devices designed into the power system provide EMI suppression. A transformer bridges the battery power to the isolated electronics. Voltage clamps and fuses provide secondary protection against loss of regulation in switching supplies on the Analog, Digital, and Recharger Boards.

Several control lines activate and deactivate the power supplies. These control lines originate on the Digital Board and are routed to the Recharger Board and Analog Board to activate the display power supply and the main power supply. The recharger supply is automatically activated any time an adequate dc power source is connected to the power input jack on the monitor's right side panel.


POWER SYSTEM DIAGRAM
DISPLAY CONTROLLER
BACKLIGHT_ON/OFF
F3
CCFL SUPPLY
RF_SUPPLY_EN
F4
+VSW
+3.3V SUPPLY
DISPLAY, +3.3V LOGIC
F2
+VSW
+5V SUPPLY
PCMCIA CONTROLLER
VCC_OVERVOLTAGE
+3.3V_OVERVOLTAGE
SHUTDOWN/
PWR_SWT_COM
MONITOR POWER CONTROL
DIGITAL BOARD
T1PIN7
T1PIN8
T1PIN9
ISO 5.9V SUPPLY
5.9V SUPPLIES FOR ISOLATED RS423
+VSW
BATT_TAP
LOW_VCC
INFREQ_INT/
RECHARGER BOARD
POWER ADAPTER
VCHG+
VCHG-
BATTERY RECHARGER SUPPLY
VCC
F1
+VSW
VCC SUPPLY +5.00V
ANALOG BOARD
F2
PWR_SWT_COM
THERM1
THERM2
POWER SWITCH
PS_CONTROL
NON-ISO POWER SUPPLIES
T1
ISOLATED POWER SUPPLIES
ISOLATED SUPPLIES
-BAT
+BAT
BATTERY
+15V
GND
-15V
IAG
(ISOLATED GND)
PIN7
PIN9
PIN8
(RS423 POWER)
BATT. COMPARTMENT

Monitoring electronics system description

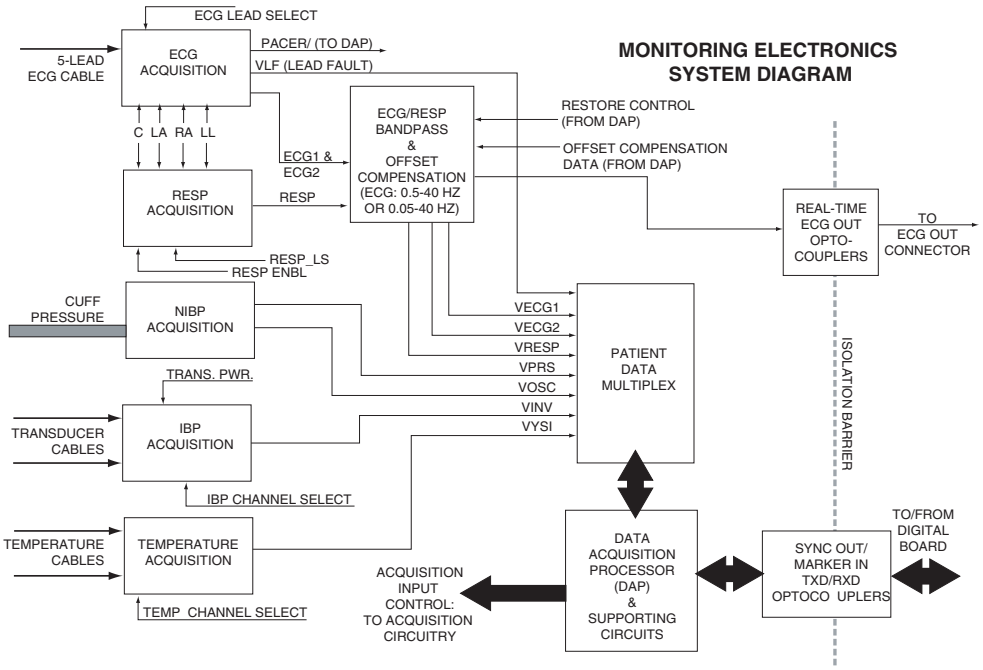
The monitoring electronics reside on the Analog and Digital Boards located in the front chassis assembly. Refer to the figures page 113, page 114 and page 115.

These circuits:

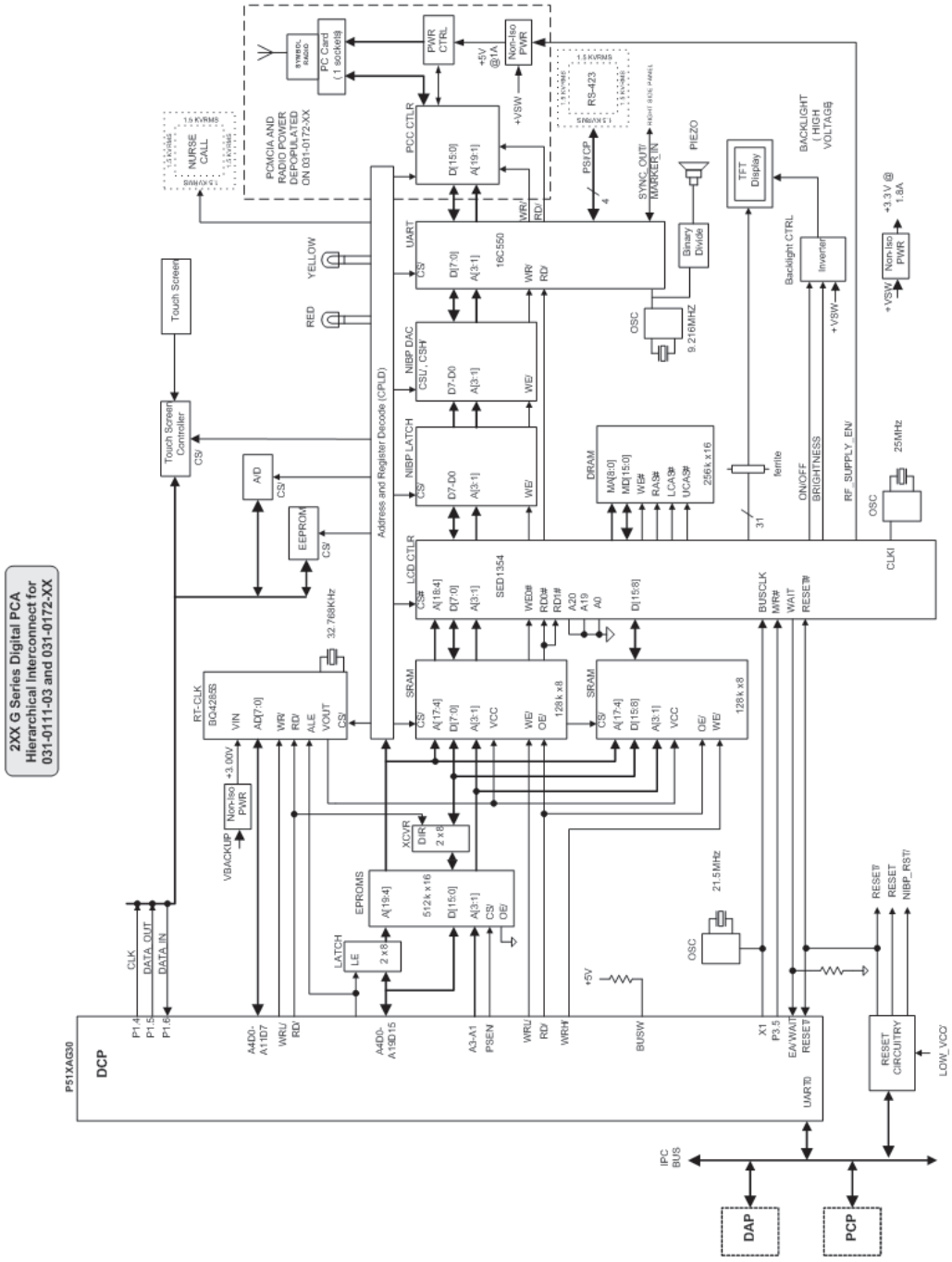
- acquire the physiological signals from coupling devices (electrodes, transducers, and probes)
- convert the analog signal to digital data
- process the data for display and alarm monitoring
- display the data and any alarm conditions
- transmits the analog ECG signal across the isolation barrier for real-time analog ECG output

Isolation barriers on the Analog and Digital Boards isolate the circuits connected to the patient from circuits connected to other devices including the monitor's power input. Communications and power delivery across the isolation barrier are achieved using opto-couplers and a transformer rated for medical applications.

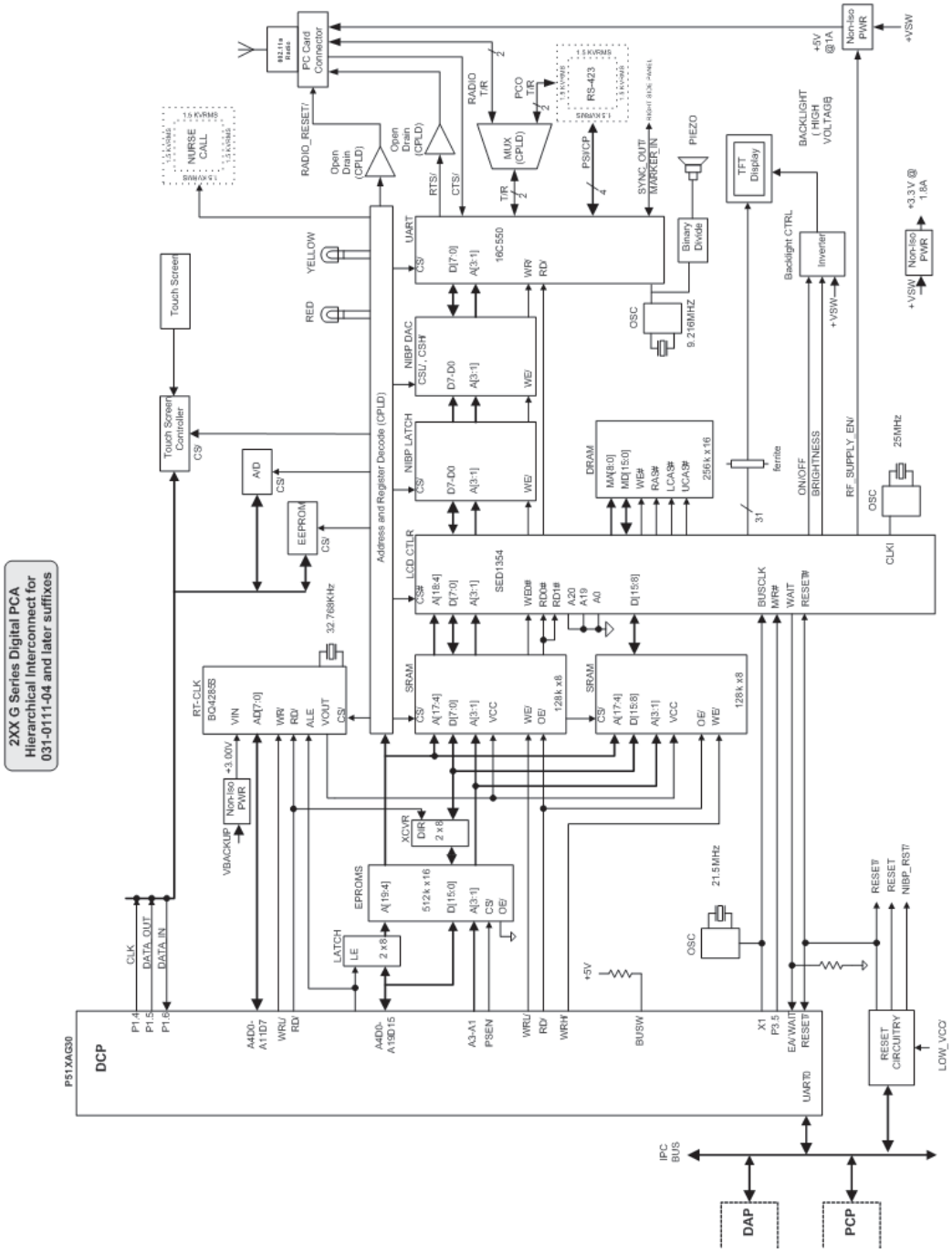
Microcontrollers (µCs) control patient data processing, alarm monitoring and display.



Digital board interconnect diagram (2.4 GHz radio card)



Digital board interconnect diagram (5 GHz radio card)



NIBP pneumatics description

The NIBP (cuff) system:

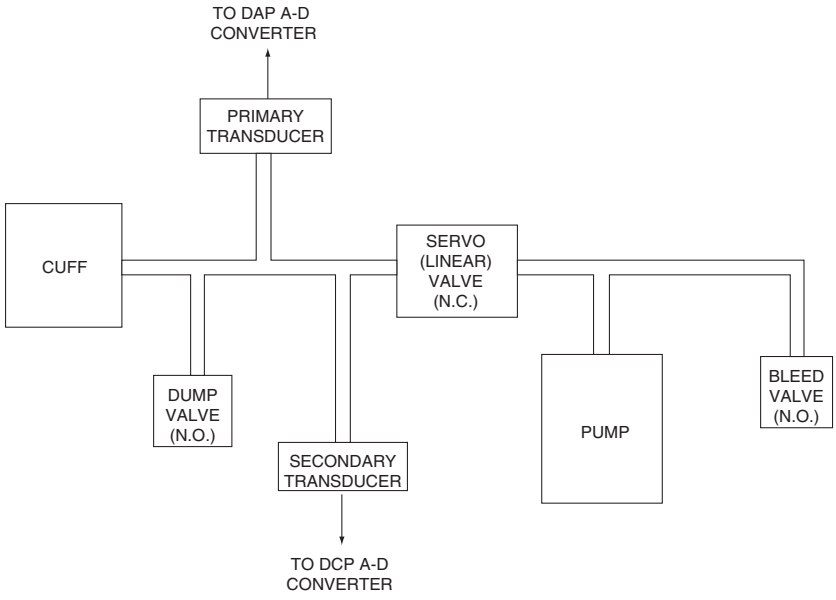
- inflates the cuff to a target cuff pressure
- converts the cuff air pressure to an electrical signal using a pressure transducer
- deflates the cuff in a controlled manner while the monitoring electronics determines blood pressure
- protects the patient from cuff over-inflation

The NIBP air system consists of the pump, air valves, transducers, and the cuff. Except for the primary transducer and cuff, all NIBP pneumatic components are located on the Recharger Board.

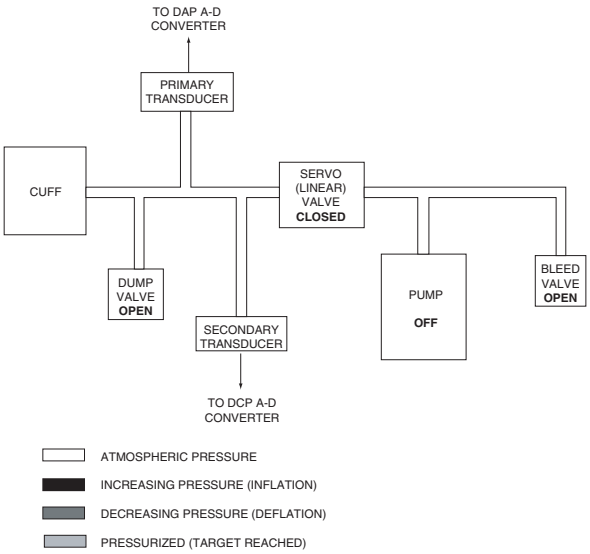
The pump inflates the cuff only when the bleed and dump valves are closed. These two valves are normally open to ensure the NIBP tubing does not remain pressurized when the valves are not energized. The linear valve's programmable iris determines the cuff inflation and deflation (bleed) rate.

Two transducers provide redundancy in pressure monitoring to ensure accurate readings and to ensure cuff deflation in an over-pressure condition. If the cuff pressure reaches the maximum allowable pressure for the patient class (adult, pede, or neonate), the dump valve opens to quickly deflate the cuff.

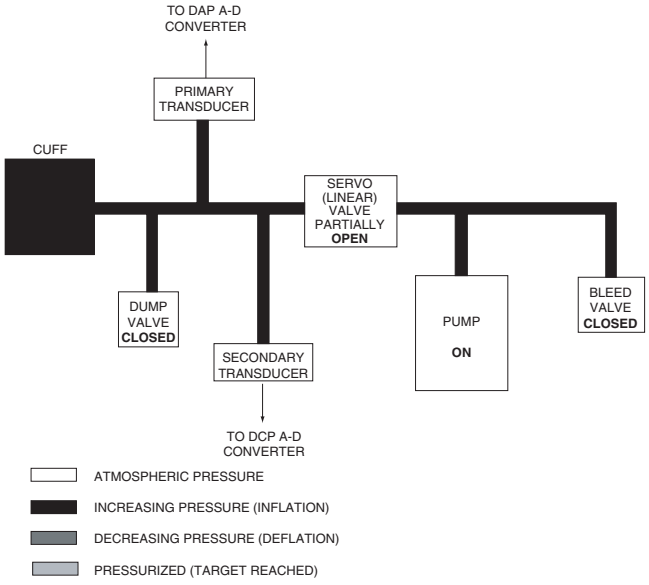
The figures on the following pages illustrate the pressure conditions during a typical NIBP measurement process.



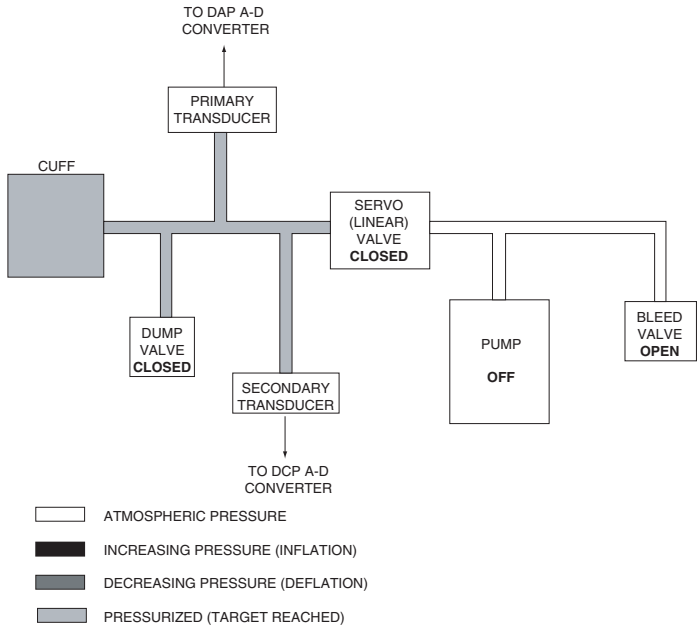
NIBP PNEUMATICS AT REST BETWEEN MEASUREMENTS



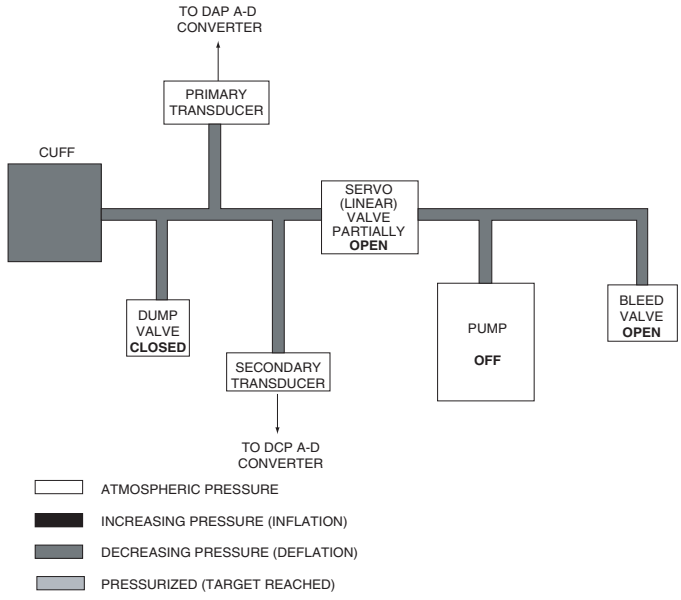
NIBP PNEUMATICS DURING PUMP UP TO TARGET PRESSURE



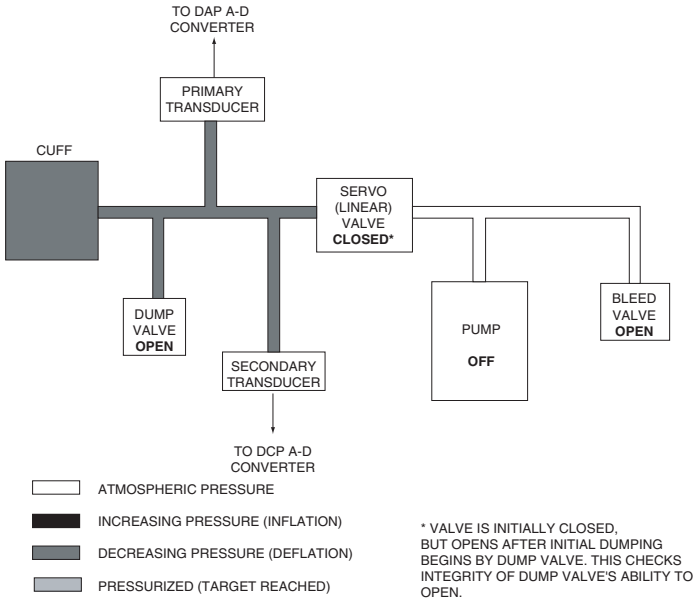
NIBP PNEUMATICS AT MAXIMUM TARGET PRESSURE



NIBP PNEUMATICS DURING MEASUREMENT BLEED

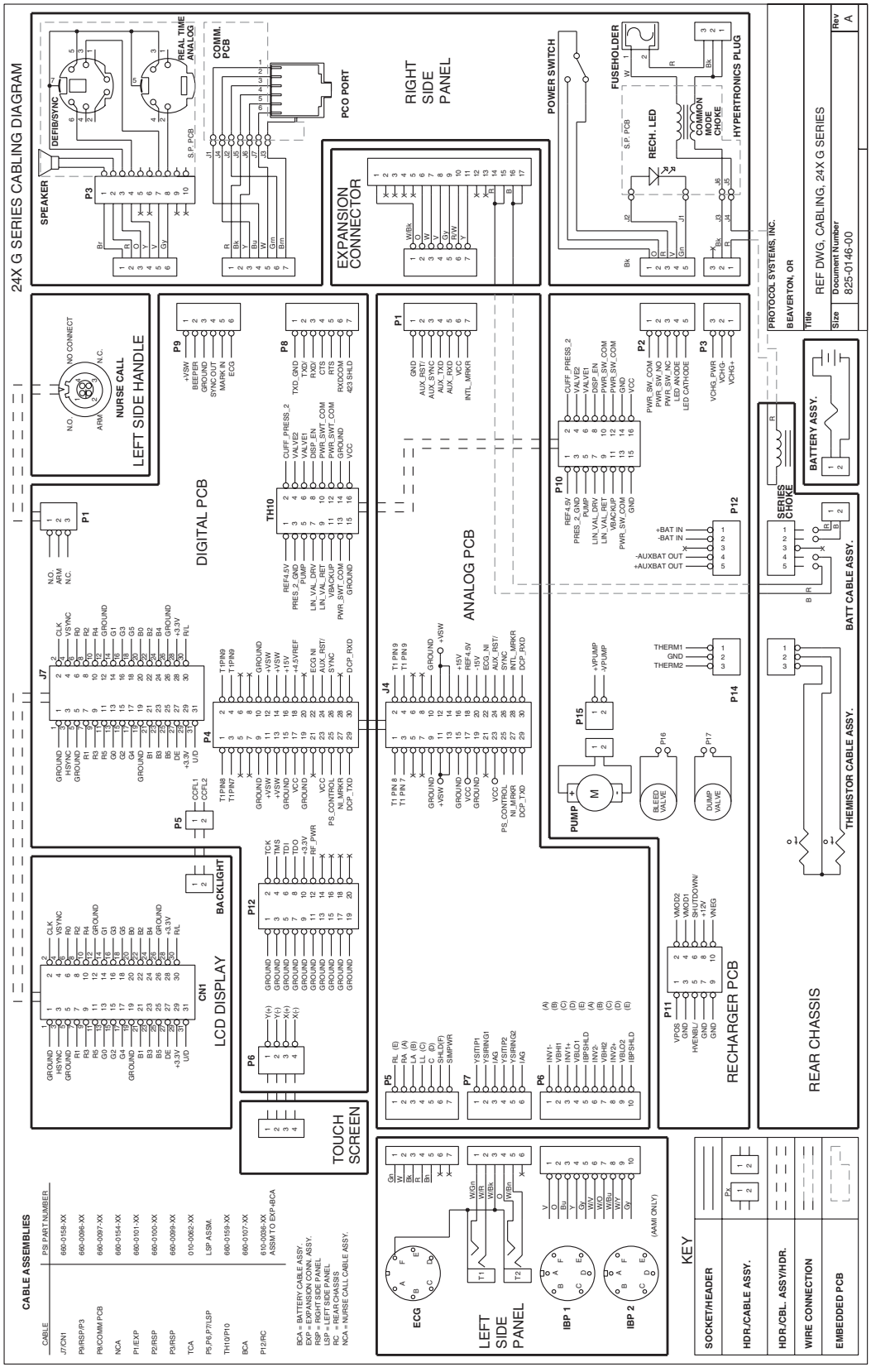


NIBP PNEUMATICS AFTER MEASUREMENT COMPLETE



* VALVE IS INITIALLY CLOSED, BUT OPENS AFTER INITIAL DUMPING BEGINS BY DUMP VALVE. THIS CHECKS INTEGRITY OF DUMP VALVE'S ABILITY TO OPEN.

Cabling diagrams



Expansion Module and printer description

The printer shares battery power with the monitor, but contains its own power supply. The printer processor communicates with the monitor's processor through the expansion connector and cable.

The Expansion Module is designed to house the monitor Printer and other circuit boards for additional parameters. The main circuit board in the Printer is the Printer Main Board. An additional circuit board (key panel) in the expansion module with printer front chassis contains the push buttons.

The Printer Main Board is attached to the thermal printer mechanism and should be replaced as a unit with the printer mechanism if repair is needed.

The Printer Main Board connects to the expansion connector, the battery pack, the push buttons on the expansion module front panel, the printer mechanism (motor and print head), and the paper out and head up sensors.

The printer’s microprocessor receives print data and control information from the monitor and sends data to the monitor. Communication between the two systems (monitor and printer CPUs) is done by sending and receiving data packets over serial communication lines.

The print head assembly contains 5 segments consisting of 64 thermal printing dots each for a total of 320 dots, which cover the width of the paper. As the paper moves under the print head, the system enables each segment energizing the thermal dots as necessary.

The Printer Main Board consists of five functional blocks: Printer CPU, Printer Driver, Printer Logic, System Power, and Printer Power. These blocks are interconnected by several control lines and buses. External to the Printer Main Board are the key panel, housed in the expansion module front chassis, and the printer motor and print head, both parts of the printer mechanism.

The Printer CPU block receives data and control information from the monitor through the Printer Logic block. The Printer CPU sends data to other printer circuits to control printer functions and sense printer conditions.

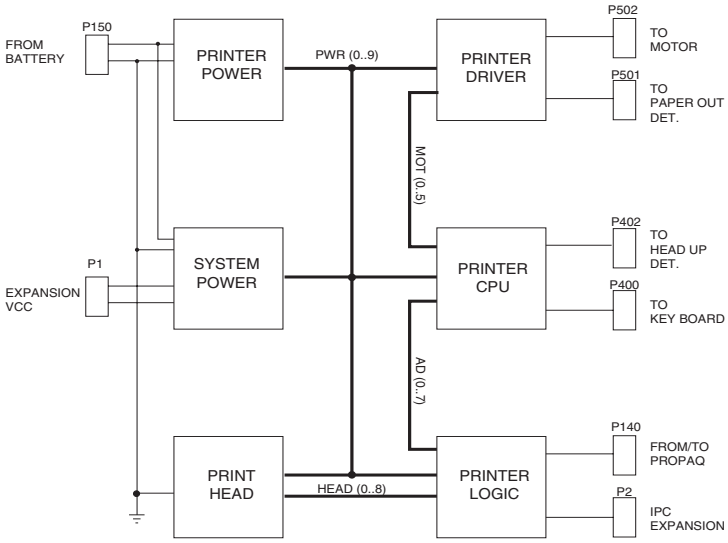
Through the Printer Driver the CPU controls the stepper motor and detects when the paper has run out.

The CPU loads print data into the Printer Logic block and, through this block, controls the individual printhead segments. The CPU also interfaces with the monitor through this circuitry.

The System Power block provides several dc power supplies to the printer.

The Printer Power block provides the +24V printer power supply.

PRINTER FUNCTIONAL BLOCK DIAGRAM



Pulse oximetry option (SpO_2) description

The monitor pulse oximetry option (SpO_2) hardware includes two circuit boards, a side-panel connector, and related hardware. The pulse oximetry option is installed in the pulse oximetry option module attached to the rear of the monitor (also known as the Baqpaq) or the expansion module when the printer or the CO_2 option are also present.

The two circuit boards include the SpO_2 Communications Processor (SCP Board) and the SpO_2 Board. The SpO_2 Board provides all necessary circuitry to receive and process oxygen saturation data from the oxygen sensor. The SCP Board prepares the data for processing by the monitor's processor, and it handles all communications with the monitor. The SCP Board also drives the SpO_2 speaker. The MSP Board replaces the SCP Board in SpO_2 applications with CO_2.

The SpO_2 option hardware consists of the following items:

- monitor/option interface circuit board (SCP Board)
- SpO_2 Board
- side-panel connector
- SpO_2 speaker
- the SpO_2 case attached to the rear of the monitor when no expansion module is present
- when a printer is present, the expansion module case attached to the bottom of the monitor

The SpO_2 signal provided by the oxygen transducer or sensor is first processed by the SpO_2 Board where it is converted to digital data, then that data is passed to the SCP Board where it is prepared for transmission to the monitor's main microprocessor.

An SpO_2 option isolated power supply, powered by monitor batteries, resides on the SCP Board, supplying power to the SpO_2 circuits only.

A connector on the side panel allows connection of an oxygen transducer directly to the monitor.

The oxygen transducer senses oxygen content of functional arteriolar hemoglobin through the use of light passed through the sensor site. The reflective/absorptive characteristics of hemoglobin at the wavelengths used allow the pulse oximetry circuits to obtain changing saturation levels, which can be processed to obtain the oxygen saturation percentage.

Wavelengths in the red and the infrared regions of light are produced by light emitting diodes (LEDs) manufactured to emit light at the required wavelengths. The reflected light is detected by a photo diode, which converts the light to an electrical signal. The LEDs are switched on and off under control of the SpO_2 microprocessor. Both are not on at the same time. As the system receives the signal from the photo diode, it knows whether the signal was derived from the red or infrared LED. Because the photo diode is sensitive to light emitted from sources other than the LEDs (ambient light), an ambient light component is subtracted from the signal during the processing of the SpO_2 data.

Note The oxygen transducers are not serviceable units.

The figure on page 125 shows a functional block diagram of a typical SpO_2 Board. The SpO_2 Board consists of the following subsystems:

- internal preamplifier and switch
- ac-coupled amplifier
- inverting amplifier with variable gain stage
- synchronous detector
- splitter
- 5-pole low pass filters
- 16-bit ADC
- internal calibration amplifier
- CPU/Control
- LED current drivers
- compare amplifiers

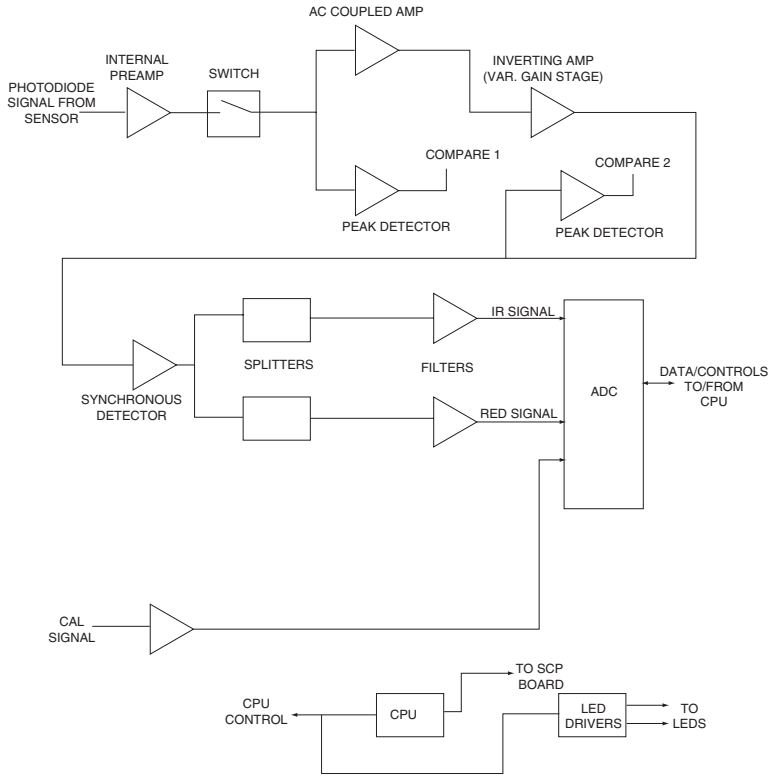
The CPU detects the presence of a transducer plugged into the D-type connector. Switch S1 routes the signal from the preamplifier to the ac-coupled amplifier. The input signal is ac-coupled to remove any dc offset present. The result is a pulse waveform representing light levels from three sources: red LED, infrared (IR) LED, and ambient. An inverting amplifier with a variable gain stage scales the signal to allow processing the best available pulse oximetry information.

Because the CPU controls the LEDS in the sensor, it knows which pulse level of the input waveform represents which wavelength of light. When the red LED is activated, the waveform level indicates red light plus ambient light. When the IR LED is activated, the waveform level indicates IR light plus ambient light. When neither LED is activated, the waveform level indicates ambient light. Only the detected red and IR light levels are used to determine the SpO_2 saturation value. The synchronous detector inverts the ambient light signal so that the ambient light signal can be subtracted from the red plus ambient light signal and the IR plus ambient light signal.

The pulses are filtered through 5-pole filter networks to remove the signal components above about 20Hz. The resulting signals indicate the detected RED and IR light levels and can then be digitized. The data from the ADC is processed by the CPU and then sent to the SCP Board for transmission to the monitor's CPU.

SpO_2 signal level is controlled through the variable gain stage of the inverting amplifier and the output current of the LED current driver. By controlling both signal gain and current drive, the CPU can maintain the best possible signal level for processing. Amplifiers sense the SpO_2 signal levels at two points, directly sending their outputs to the CPU. The CPU monitors these levels as it sets the gain stages of the inverting amplifier and LED current driver.

PULSE OXIMETRY BLOCK DIAGRAM



Capnography (CO_2) description

Two capnography (CO_2) monitoring options are available—the Mainstream-sampling CO_2 option (MCO_2) and the Sidestream-sampling CO_2 option (SCO_2).

Both Mainstream CO_2 and Sidestream CO_2 options are available in one product. However, only one sampling method may be monitored at any time—simultaneous monitoring of MCO_2 and SCO_2 is not supported.

The Mainstream CO_2 Board (MSP Board) supports all Mainstream and Sidestream applications and is the major interface between the printer and SpO_2 hardware in certain configurations of the Expansion Module. The MSP Board replaces the SCP Board in SpO_2 applications with CO_2. For Sidestream-only applications, an MSP Board version without Mainstream hardware is used. For both Mainstream and Sidestream applications, the MSP Board is mounted within the rear panel of the Expansion Module housing.

Mainstream CO_2 Option. In the Mainstream sampling method, the CO_2 analysis chamber (commonly referred to as the "bench") is an integral part of the Mainstream sensor which is located in-line, between the patient's airway and the ventilator circuit via an airway adapter. The patient's expired gas is sampled directly from the patient's airway. The MSP Board interfaces the external Mainstream sensor to the monitor.

Sidestream CO_2 Option. In the Sidestream sampling method, the bench is located on the Stick Board within the monitor. A sample of the patient's expired gas is aspirated from the airway and is drawn to the bench through a sampling line containing a water trap. The Stick Board also contains pneumatic tubing that connects to the SSP Board. The Stick Board is mounted on the Sidestream Processor Board assembly (SSP Board) which interfaces the Stick Board to the monitor. The SSP/Stick Board assembly is mounted within the front bezel of the Expansion Module housing of the monitor.

System Interface. The SSP Board power and communication is obtained via the extender board that connects to the MSP Board. The extender board routes datalines from the MSP Board and contains additional power supplies for powering the SCO_2 Boards.

The Mainstream CO_2 Board (MSP Board) is the major interface connection between several subsystems in the Expansion Module. This circuit board connects directly to the expansion connector, providing a direct interface to a monitor Display Processor system.

The MSP Board also supports:

- Mainstream CO_2
- an interface to the SpO_2 system
- an interface to the Printer option
- an interface to Sidestream CO_2

Mainstream Board

The MSP Board is divided into isolated and non-isolated circuitry.

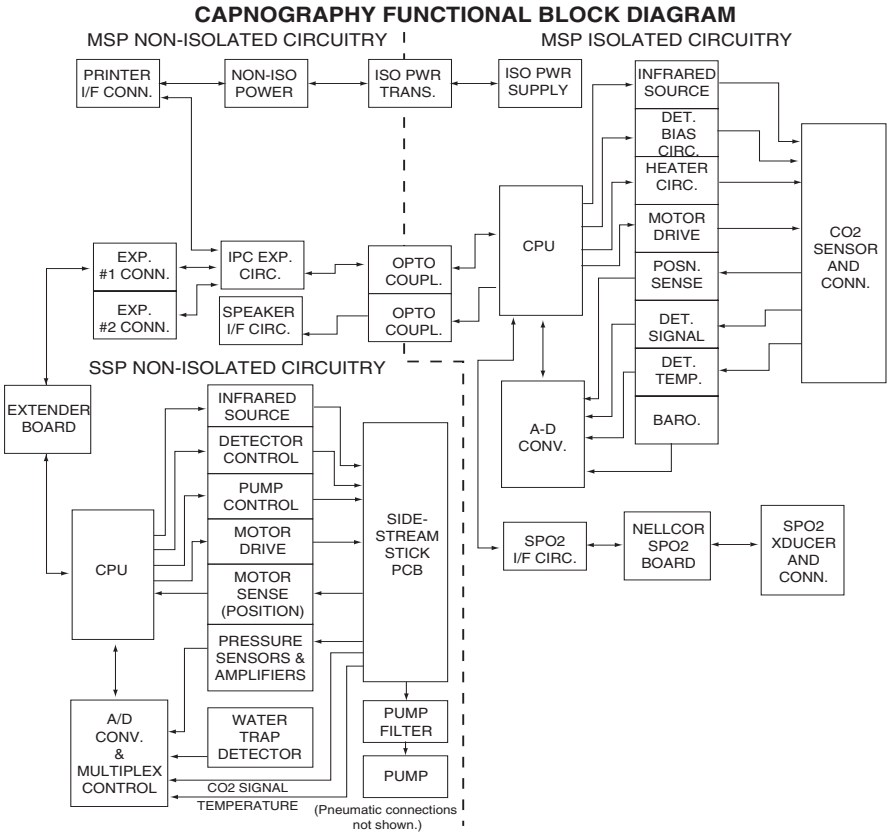
Non-Isolated Circuitry. The Non-Isolated circuitry on the MSP Board interfaces with the monitor, the printer, the speaker, P6 and P7 expansion connectors, and with the Mainstream Processor which resides on the isolated section of the MSP Board.

Isolated Circuitry. The Isolated Circuitry directly controls the hardware responsible for the CO_2 measurement function.

CPU Circuitry. The CPU Circuitry includes the Philips 80C552 micro controller, 32K of RAM, 64K of ROM, and standard RESET circuitry.

A UART directly interfaces with the pulse oximetry SpO_2 Board providing the SpO_2 measurement function.

The CO_2 and SpO_2 functions are isolated from all other subsystems in the monitor or Expansion Modules, but not from each other.



IPC expansion

The Inter-Processor Communications (IPC) bus, originating in the monitor, is passed to the MSP Board from the expansion connector. The two-wire bus is expanded to the printer and to the Mainstream Processor via opto-couplers.

Power distribution system

Power for CO_2 and SpO_2 circuit operations is derived solely from the expansion connector. The principal supply comes from the monitor battery connections and an on-board switching power supply.

CO_2 analysis chamber (bench)

Analysis of the expired CO_2 occurs in the bench. The bench is located in the Mainstream sensor for MCO_2 or on the Sidestream Stick Board for SCO_2.

In Mainstream applications, the sensor mounts over, and connects to, a disposable airway adapter (cuvette) through which the patient's exhaled gases flow. In Sidestream applications, a sample of exhaled gases is obtained through a small diameter sampling tube and routed to the bench located on the Stick Board.

Unless otherwise noted, the following details are common for bench operation in both sampling methods.

The bench consists of infrared (IR) light source and filter, a revolving chopper wheel, and a photodetector.

The chopper wheel is an aluminum disk containing a sealed CO_2 reference cell, an open slot, and a light-blocking area. The chopper wheel spins in the direct path of the IR light source.

The IR source is located on one side of the bench and is projected through the gas sample (in the airway adapter in MCO_2; routed directly to the bench in SCO_2) to a photodetector at the other side of the bench. As the IR beam passes through the gas sample to the photodetector, the components of the spinning chopper wheel are passed through the beam with each revolution.

The amplified photodetector output signal is modulated by the revolving chopper wheel and is referred to as VSIG. Each rotation of the chopper wheel generates two VSIG peaks of differing size, and a low flat spot. The voltages representing these points are called Vpeakhi, Vpeaklo, and Vdark. These correspond to the open slot, the CO_2 reference cell and the light blocking areas on the chopper wheel, respectively. The VSIG output from each complete rotation of the bench chopper wheel, occurring every thirty milliseconds, together with a known bench temperature and calibration constants stored in an EEPROM (located in the Mainstream sensor connector or the Sidestream Stick Board), provides all required information to determine the CO_2 value.

8 Field Replaceable Units (FRUs)

To order a field-replaceable unit, contact Welch Allyn Technical Support as described in page ii.

Replacement part description	Part number
Monitor Circuit Board assemblies	
ANALOG PCB, 24X (MODELS with S/N GA0) (Requires software version 3.5X and later.)	020-0577-00
ANALOG PCB, 24X (MODELS with S/N GA1) (Requires software version 3.60.00 and later.)	020-0577-01
RADIO/ANTENNA ASSY., 5 GHz, 802.11a (Requires digital PCBA with suffix -04 or greater)	020-0691-00
RADIO/ANTENNA ASSY., 2.4 GHz, PCMCIA (Requires digital PCBA with suffix -02 or -03)	020-0608-00
RECHARGER PCB, EL, 2XX (Use with display part number 500-0024-00)	020-0576-00
RECHARGER PCB, EL, 2XX (Use with display part number 500-0046-00)	020-0616-00
Display assemblies	
DISPLAY MODULE, COLOR, INCLUDES ADAPTER PLATE	020-0605-00
Monitor Front/Rear Chassis parts (labels not included)	
FRONT CHASSIS WITH TOUCHSCREEN & INTERFACE CHASSIS (Replacement requires programming at Welch Allyn Service Center.)	020-0597-02
FRONT CHASSIS WITH TOUCHSCREEN & INTERFACE CHASSIS WITH NURSE CALL (Replacement requires programming at Welch Allyn Service Center.)	020-0619-01
INTERFACE CHASSIS, 24X STANDARD	020-0603-01
INTERFACE CHASSIS, 24X WITH NURSE CALL	020-0604-01
REAR CHASSIS	020-0512-00
Monitor side panels (labels not included)	
LEFT SIDE PANEL, AAMI CONNECTORS, ALL MODELS, (MODELS with S/N, GA0)	010-0138-02
LEFT SIDE PANEL, AAMI CONNECTORS, (MODELS with S/N GA1)	010-0138-03
LEFT SIDE PANEL, HP CONNECTORS, ALL MODELS	010-0157-01
RIGHT SIDE PANEL	010-0151-02
NIBP System parts	
PUMP	680-0051-00
NIBP PLUMBING, AAMI CONNECTORS, ALL MODELS	020-0513-00
NIBP PLUMBING, HP CONNECTORS, ALL MODELS	020-0514-00
INTERNAL TUBING, SILICONE, 2 FEET, 0.104" ID	008-0009-00
INTERNAL TUBING, SILICONE, 1 FOOT, 0.125" ID	600-0179-00

Replacement part description	Part number
NIBP HOSE FITTING, PLASTIC, PAIR	020-0065-00
NIBP CONNECTOR, HOSE END, NICKEL PLATED	600-0021-00
VALVE, BLEED/DUMP (VLV1, VLV2)	680-0050-00
VALVE, LINEAR SERVO (VLV3)	680-0049-01
Miscellaneous components for monitors	
FUSE, 2AG - 3A, SLO BLO, 250 V, EXTERNAL, 1 EACH	503-0058-00
FUSES, 3A PICO FUSE, 125 V, QTY. 10	020-0210-00
FUSE, 25W POWER ADAPTER, 5x20mm, **400** mA, 250V, SLO-BLO (for 240 volt application)	503-0056-00
FUSE, 25W POWER ADAPTER, 5x20mm, **800** mA, 250V, SLO-BLO (for 120 volt application)	503-0057-00
SWITCH, ON/OFF, POWER, W/O BOOT	680-0010-01
FOOT PADS, QTY. 24	020-0033-00
HANDLE	020-0034-00
HANDLE, BLUE	630-0156-00
HANDLE, ROSE	630-0165-00
HANDLE, TEAL	630-0166-00
SWITCH, ON/OFF, POWER, W/O BOOT	680-0010-01
BOOT SEAL, POWER SWITCH	680-0006-00
CABLE ASSY., 10-PIN RIBBON, DIGITAL TO RECH. PCB	660-0102-00
ANTENNA CAP WITHOUT WIRELESS; AISO NURSE CALL CAP (WHITE)	630-0161-00
ANTENNA CAP WITH ANTENNA ICON (YELLOW)	630-0187-00
Expansion Module/Printer options	
PRINTER ASSEMBLY, 2XX	020-0579-00
PRINTER ASSEMBLY, ESD, 2XX	020-0602-00
MAIN CHASSIS, EM **W/O** PRINTER FOR CO2 CONN. **W/O** BRACKET	020-0583-00
MAIN CHASSIS, EM **WITH** PRINTER, ESD	020-0600-00
MAIN CHASSIS, EM **W/O** PRINTER, ESD	020-0599-00
FRONT PANEL	020-0515-00
REAR PANEL	020-0071-00
PAPER DOOR	020-0074-00
CAP, HORIZONTAL KEY	630-0087-00
KEY PAD, ELASTOMERIC	630-0086-00
FUSE, 15A PICO, 125 VOLT, ONE EACH	503-0019-00
Pulse oximeter options	
SPO2 INPUT BOARD, NELLCOR MP-203	020-0473-00
SPO2 INPUT BOARD, NELLCOR MP-405	031-0130-00
SPO2 INPUT BOARD, NELLCOR MP-507	031-0152-00
SPO2 INPUT BOARD, NELLCOR NELL-2	031-0170-00
SPO2 INPUT BOARD, MASIMO MS3	031-0129-02

Replacement part description	Part number
SCP BOARD, NELLCOR MP-203 ONLY, U11 64K PROM	020-0476-00
SCP BOARD, NELLCOR / MASIMO, U303 128K PROM	031-0133-03
FRONT CHASSIS, SPO2 ONLY	020-0122-01
REAR CHASSIS, SPO2 ONLY	020-0123-01
MOUNTING SCREWS WITH WASHERS	020-0126-00
SPEAKER PANEL ASSEMBLY	020-0125-01
SPO2 CONNECTOR PANEL, NELLCOR MP-203 (W/O LABEL)	020-0190-00
SPO2 CONNECTOR PANEL, NELLCOR MP-405	010-0210-02
SPO2 CONNECTOR PANEL, NELLCOR MP-507	010-0231-00
SPO2 CONNECTOR PANEL, MASIMO MS3 - MINI DIN CONNECTOR WITH SHROUD	010-0208-00
SPO2 CONNECTOR PANEL, MASIMO MS3 WITH MASIMO STYLE CONNECTOR	010-0236-00
LOCKING "D" CONNECTOR, SPO2 PANEL	630-0038-00
CO_2 option, Mainstream/Sidestream	
MSP BOARD, **WITH** MCO2, MP-203 ONLY, U11 64K PROM, D/E/G SERIES	020-0580-00
MSP BOARD, **W/O** MCO2, MP-203 ONLY, U11 64K PROM, D/G SERIES ONLY	031-0058-51
MSP BOARD, **WITH** MCO2, MS3 / ALL NELLCOR, U1 128K PROM, D/G SERIES ONLY	031-0058-03
MSP BOARD, **W/O** MCO2, MS3 / ALL NELLCOR, U1 128K PROM, D/G SERIES ONLY	031-0058-53
CO_2 option, Mainstream	
CONNECTOR PANEL, CO2, **W/O** BRACKET	020-0582-00
MAINSTREAM CO2 SENSOR EXCHANGE (CO2 sensor listed is exchange for reworked sensor II, 90 day warranty)	108-0502-00
MAINSTREAM CO2 SENSOR TRADE-IN (CO2 sensor listed is trade-in for new sensor II, one year warranty)	008-0502-00
CO_2 option, Sidestream	
SSP BOARD (Requires Service Center calibration)	020-0574-00
STICK BOARD (Requires Service Center calibration)	031-0094-02
EXTENDER BOARD	031-0092-00
FRONT PANEL, EMP, SSCO2	020-0575-00
Option interconnect cables	
CABLE, POWER HARNESS, EM	660-0090-00
CABLE, PROPAQ P4 TO PCP-P140	010-0055-00
CABLE, PROPAQ P4 TO SCP/MSP-P1	010-0048-00
CABLE, SCP-P4 TO PCP-P140	010-0054-00
CABLE, MSP-P4 TO PCP-P140/KEYPAD TO PCP-P400	010-0056-00
Labels, all language applications	
LABEL, MODEL 242	640-0506-00
LABEL, MODEL 244	640-0507-00
LABEL, MODEL 246	640-0508-00
LABEL, RIGHT SIDE PANEL	640-0325-00

Replacement part description	Part number
LABEL, RIGHT SIDE PANEL, ACUITY **(NO LONGER AVAILIBLE)**	640-0326-00
LABEL, RIGHT SIDE PANEL, NETWORKS/ACUITY/MODEM	640-0422-00
LABEL, LEFT SIDE PANEL, 2X2, AAMI, UNIVERSAL	640-0321-01
LABEL, LEFT SIDE PANEL, 2X2, HP, UNIVERSAL	640-0356-01
LABEL, LEFT SIDE PANEL, 2X2/RESP., AAMI, UNIVERSAL	640-0329-01
LABEL, LEFT SIDE PANEL, 2X2/RESP., HP, UNIVERSAL	640-0355-01
LABEL, LEFT SIDE PANEL, 2X4, AAMI, UNIVERSAL	640-0320-01
LABEL, LEFT SIDE PANEL, 2X4, HP, UNIVERSAL	640-0354-01
LABEL, LEFT SIDE PANEL, 2X4/RESP., AAMI, UNIVERSAL	640-0328-01
LABEL, LEFT SIDE PANEL, 2X4/RESP., HP, UNIVERSAL	640-0353-01
LABEL, LEFT SIDE PANEL, 2X6, AAMI, UNIVERSAL	640-0319-01
LABEL, LEFT SIDE PANEL, 2X6, HP, UNIVERSAL	640-0352-01
LABEL, LEFT SIDE PANEL, 2X6/RESP., AAMI, UNIVERSAL	640-0327-01
LABEL, LEFT SIDE PANEL, 2X6/RESP., HP, UNIVERSAL	640-0351-01
LABEL, SPO2 CONNECTOR PANEL	640-0443-00
LABEL, BATTERY COVER	640-0031-01
LABEL, SPO2 ONLY	640-0331-07
LABEL, EMP REAR PANEL	640-0385-05
LABEL, CONNECTOR PANEL, CO2	640-0444-00
LABEL, EMP, PRINTER DOOR PANEL	640-0322-01
LABEL, REAR, SOLO/SPO2 ONLY, WIRELESS	640-0535-00
LABEL, REAR, EXPANSION MODULE, WIRELESS	640-0537-00
Labels, English applications	
LABEL, PRINTER KEY PANEL	640-0332-00
Labels, Dutch applications	
LABEL, PRINTER KEY PANEL	640-0468-00
LABEL, BLANK	640-0267-00
Labels, French applications	
LABEL, PRINTER KEY PANEL	640-0372-00
Labels, German applications	
LABEL, PRINTER KEY PANEL	640-0373-00
Labels, Italian applications	
LABEL, PRINTER KEY PANEL	640-0450-00
Labels, Portuguese applications	
LABEL, PRINTER KEY PANEL	640-0462-00
Labels, Spanish applications	
LABEL, PRINTER, KEY PANEL	640-0371-00
Labels, Swedish applications	

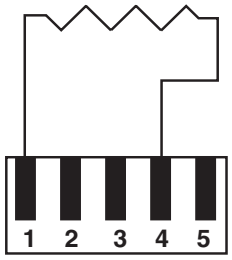
Replacement part description	Part number
LABEL, PRINTER KEY PANEL	640-0465-00
Special service tools	
NIBP CALIBRATION SETUP TUBING ADAPTER KIT	008-0012-01

A Manufacturable test equipment

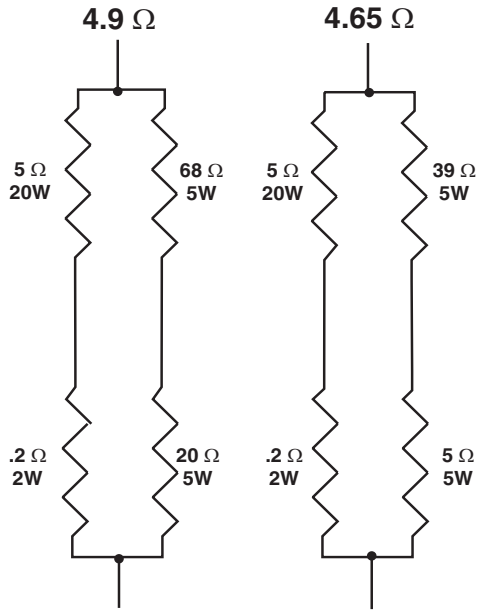
The following device(s) can be manufactured for use in the functional verification and calibration procedures in this manual. Parts are readily available from electronic component suppliers.

RESISTIVE TEST LOADS
(USED TO ADJUST RECHARGER POWER SUPPLIES)

USE RESISTOR NETWORKS TO RIGHT AND CREATE TWO (2) SEPARATE TEST LOADS: 4.9 OHM AND 4.65 OHM LOADS



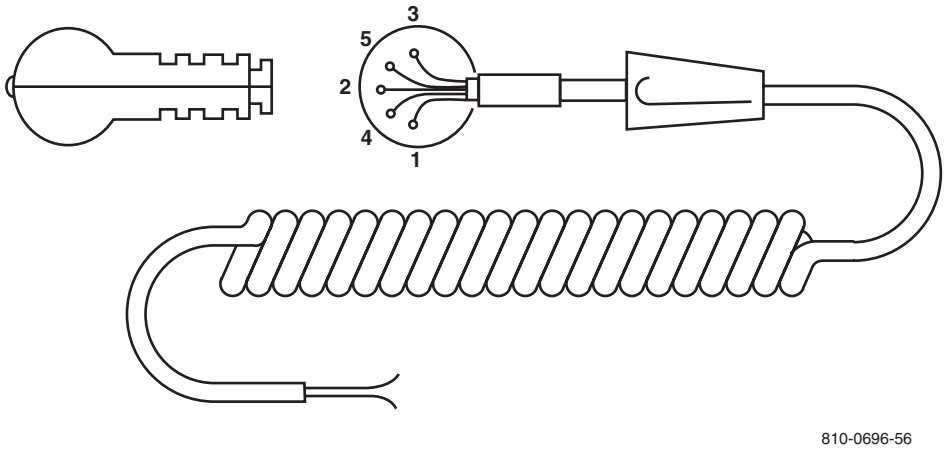
CONNECTOR: 5-PIN, 0.156" CENTER
MFR: METHODE; PN 3300-405-220
PROTOCOL PN: 610-0036-00
(REQUIRES INSERTION TOOL
Welch Allyn PN: 610-0036-00



B Fluke patient simulator modification

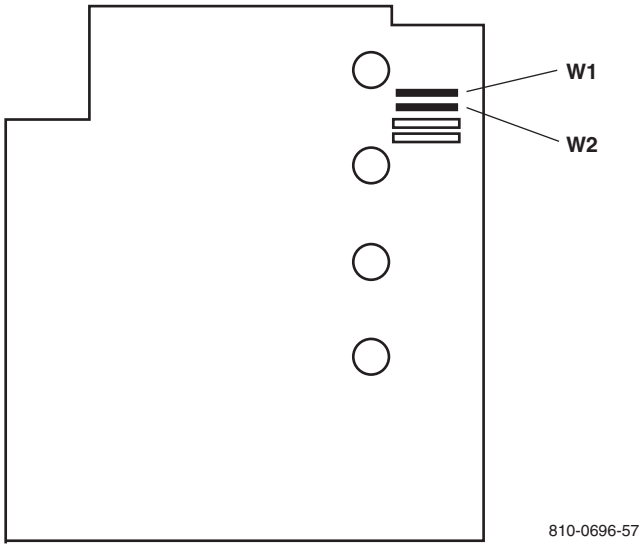
The factory configuration of the Fluke (Dynatech/Nevada) model 214A, 215A, and 217A Patient Simulators is incompatible with the Propaq CS monitors with IBP channels when both the ECG and invasive pressure simulator channels are simultaneously connected to the monitor. Erroneous readings result. The patient simulator must be modified as described here before you can use both simulator channels with the Propaq CS monitors with IBP. If only one simulator channel is used, the modification is unnecessary.

Modify the patient simulator's invasive pressure cable as shown in the figure below.



Note Without this modification, the monitor will select a single waveform or parameter for display.

Remove jumpers W1 and W2 from the patient simulator's Top PCB.



Incompatibilities with other simulators may also cause erroneous readings and/or missing ECG. Check Propaq CS monitor readings with the simulator against a known source before using the simulator for calibration.

Function	Color	Pin No.	Propaq CS 244/246
Output (+)	Black	4	C
Output (-)	Red	1	A & E
Exciter (+)	White	3	B
Exciter (-)	Green	5	D
ECG Ref	Blue	2	No Connection